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A Short History of the Lick Observatory*

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PART III

THE ASTRONOMICAL SOCIETY OF THE PACIFIC

The Astronomical Society of the Pacific was founded by Holden and deserves some space in this Short History of the Lick Observatory. A plan for forming an astronomical society for professional and amateur astronomers was in Holden's mind before he came to the Lick Observatory. At that time there existed in the United States many local astronomical associations, but none of national or international character. The total solar eclipse of January 1, 1889, which was visible in Northern California, aroused everyone's curiosity and this occasion gave Holden the chance he needed. Shortly before the eclipse took place, he wrote many letters to people whom he considered to be interested in such an organization and called for a meeting at the Lick Observatory to discuss the matter. At this meeting forty signified their intention of joining and the Astronomical Society of the Pacific was formed. Holden was its first President, Schaeberle was the first Secretary. The by-laws called for a society that was to be "popular in the best sense of the word," according to Holden's own statement. It was to publish a bi-monthly Journal, called "Publications of the Astronomical Society of the Pacific" which was to inform the members regularly of the best and latest in astronomical science, publish notes of observations made by members, and also give reports of the activity of the observatories of the world and of the Lick Observatory in particular. Everyone was welcome and was invited to join. Half of the meetings were to be held in San Francisco, and the other half at the Lick Observatory on Saturdays when the telescopes were available for the public. The first number of its *Publications* appeared on February 7, 1889, with the names of the forty charter members and the by-laws. The second number is entirely from Holden's pen entitled "On the Work of an Astronomical Society." It was a well written and very informative article reviewing the great European astronomical organizations. One may read this article now and find it still very interesting in spite of its having been published 62 years ago. For the following numbers of the *Publications*, the staff of the Lick Observatory supplied many

*Continued from August (1950), page 334.

articles and illustrations, and one may safely state that the Astronomical Society of the Pacific became very "popular in the best sense of the word" from its beginning, as Holden wished it to be.

At the meeting of July 27, 1889, the membership had increased to 119, thirteen of whom were Life Members. The names of the latter read like a "Who's Who" on San Francisco's Montgomery Street, the "Wall Street of the West." Holden persuaded Mr. Joseph A. Donohoe of Menlo Park, California, to give $500.00 for a fund toward the Comet Medal of the Astronomical Society of the Pacific, and also succeeded in securing a fund of $2,500.00 "in gold coin of the United States" for a library for the Society, to be known "forever after" as the Alexander Montgomery Library of the Astronomical Society of the Pacific. Mr. Alexander Montgomery of San Francisco was one of the original charter members. The Treasurer's report at that meeting is very illuminating. There was on hand the sum of $4,120.75 in cash after the expenses of the Society had been paid for the first six months of its existence, a good example to be followed by similar scientific societies anywhere.

However, Holden's dream of securing sufficient funds for a gold medal so that the Astronomical Society of the Pacific could "adequately" recognize scientific work took several years for its realization. In the spring of 1897 Miss Catherine Wolfe Bruce of New York informed him that a sum of $2,500.00 was available for that purpose with the usual restrictions on such gifts: that the medal be international in character, that it may be given to a citizen of any country, and that it may be awarded to persons of either sex and only once to any recipient. The first award went to Simon Newcomb on April 2, 1898, but Holden was not there at that memorable meeting for he had left Lick Observatory and California some months before, never to return.

These short notes relating to the origins of the Astronomical Society of the Pacific bring out plainly the fact of Holden's ability to organize and to approach and make contacts in high financial and social circles. He made these rather easily, all of great benefit to the Society and likewise to the Lick Observatory. But, in spite of all these great abilities, he never seemed able to make an intimate and lasting friendship. His name almost disappeared from the *Publications* after he once left. The rather long letter of resignation to the Regents of the University of California is printed in full in the *Publications*, and true to his own self to the last, it had to be published in the larger San Francisco papers so everyone could read it.

Early Days on Mt. Hamilton

Another event occurred which caused a good deal of newspaper talk in California during the last few months of the year 1888. The news arrived in California that Alvan Clark was making a 40-inch lens for some institution in Southern California. This hurt the pride of many Northern Californians for "their" Lick Observatory would no longer

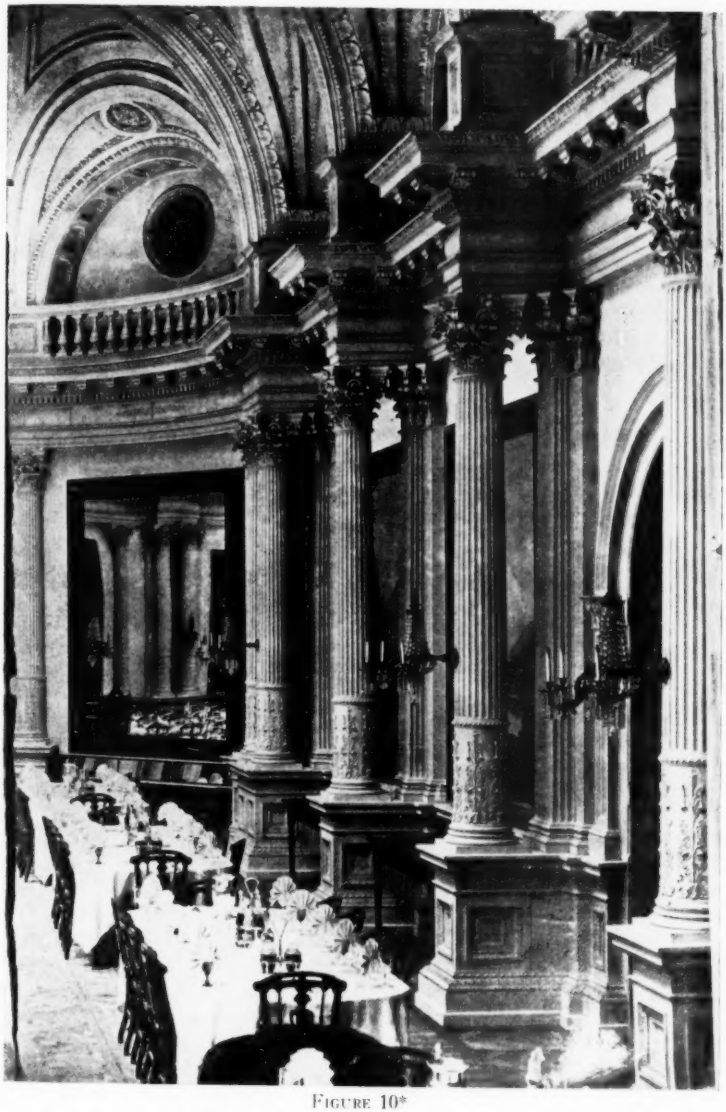

FIGURE 10*

A corner of the dining room of the Lick House in San Francisco in 1871.

*This and the following photographs belong more appropriately in the earlier installments. However, they came to light too late for use there. Since they have not been published before and because of their historic and intrinsic interest, they are included in this part. EDITOR.

have the most powerful telescope in the world. Clark even talked of a possible lens of 60 inches in diameter. Holden had to write many articles for the papers either explaining the possibility of such lens or maintaining that no loss of prestige of the Lick Observatory need to be feared. In the meantime, young Barnard discovered several comets, always big news, and the press felt cheated at not receiving the news in time. Moreover, the California press was not alone in this complaint. Even the dignified *Atlanta Constitution* took up the argument in an editorial, a copy of which Holden kept among the numerous scrapbook items with the annotation "May the God of our fathers defend us from any more like this."

Just shortly before the eclipse of January 1, 1889, the papers attacked Holden for the way he ruled Mt. Hamilton and his treatment of visitors. "The Emperor of Mt. Hamilton uses his power to deny the public a visit to a public institution supported by taxpayers' money. Does he own the place?" But, in spite of these attacks, the astronomical work went on normally, each member of the staff worked at his own problem, and, fortunately for the residents on the mountain, the winter of 1888-1889 was rather a mild one.

The eclipse had been observed successfully. Holden informed the papers about the results, rather about promised results. The staff members gave lectures before various organizations which were very favorably commented upon by the press. Burnham discovered many new double stars. Keeler worked on most any phase of astronomical research, put his stellar spectrograph in order and made the now famous visual observations of the spectra of planetary nebulae and bright line stars. He also determined the radial velocities of three brighter stars. Barnard worked with the 12-inch telescope and now and then was permitted to use the greater refractor. By the end of 1890 he had the credit of the discovery of thirteen comets. Schaeberle had several meridian circle programs going and computed several orbits. Young Leuschner was seen day and night with "Oppolzer's Bahnbestimmung" under his arm in which he corrected the many typographical errors and erroneous formulae.

There was more trouble for Holden ahead early in the year 1889. Shortly after New Year of 1889 the State Legislature in Sacramento appointed a Committee on Education which was to visit the University in Berkeley, the State Normal School in San Jose, and the Lick Observatory. This committee was expected to give a full report to the Legislature in the short time such committees are given, in order to judge the amount of the appropriations to be allotted to these institutions. The committee met in San Jose after their official inspection of the Normal School and expected to visit the Lick Observatory. They claimed that they telephoned to the Director of the Lick Observatory about their contemplated visit, but either the line was out of order (which frequently was the case in the early days) or there was no one at the

switchboard. The day was a Saturday, a cold, inclement day and the six hours drive by members of the committee was anything but pleasant. Upon arrival at the top in the late afternoon they found no one in the main observatory building to receive them. Perhaps on account of the bad weather conditions, none of the staff expected anyone to come to the Observatory. The committee found the visitors' room, made the best of it, and some of the members looked for someone to take them to the Director's apartment. However, they reported that they found the door of the "mansion" locked, and "even rapping with a cane could not invoke a host." Finally a "young faculty member" showed up and offered to show them the instrument, not knowing who they were. They expected a warm fire and some food and some rest from their tiresome journey up the mountain. They left disgusted and returned to their hotel in San Jose. They arrived early the next day worn out and in no state of mind to do anything except talk about their cold reception. As always, reporters were on hand and made the most of the episode. Headlines, inches high, appeared in the papers about the cold reception of the Legislative Committee. The Chamber of Commerce of San Jose went to work on a resolution and had it introduced into the State Legislature to have Holden removed. Nothing came of this resolution, but appropriations were cut that session for all three institutions.

During the winter months of 1888-1889, the community was not quite prepared to make living conditions comfortable as compared with living at lower altitudes. Heating of offices and living quarters was by wood stoves, and electric lights had as yet not replaced oil lamps. The latter were the cause of worry for Holden because of the fire hazard which was always present. But every member of the community took all hardships in his stride as all were young people. In the spring of 1889 Keeler made observations of the satellites of Mars and reported on the appearance of Saturn and its Rings and of Uranus. He also reported observing the spectra of these planets, visually of course. Barnard mounted the newly purchased 5-inch portrait lens, called the Willard, and began his work of photographing the Milky Way by means of this lens and a homemade camera attached to the 12-inch refractor. Schaeberle and Leuschner computed several orbits and the latter continued to correct and annotate the copies of "Oppolzer's Bahnbestimmung," the Bible of that day for the theoretical astronomer.

Holden, always having visitors in mind, designed a low-power eyepiece for the 36-inch with a large field of about one-half a degree for viewing the entire Moon through the 36-inch refractor. This eyepiece was made by the Grundlach Optical Company of Rochester, N .Y., and was freely used on visitors' nights during Holden's days. It is still used now and then. Holden also recorded the mean rainfall on Mt. Hamilton for several years finding it to be 33.41 inches. There was still a good deal of talk about the new Clark 40-inch lens for "some institution in the southern part of California" as the San Francisco papers called the

FIGURE 11
Arrival of 36-inch lens on Mt. Hamilton.

University of Southern California, but there was only the sum of $150,000 available for the project.

Toward the end of 1889, Holden announced that, due to the generosity of one member of the Astronomical Society of the Pacific, the Lick Observatory would send Burnham and Schaeberle to Cayenne, South America, to observe the total solar eclipse on December 21, 1889. The Willard lens was permanently mounted equatorially and provided with a driving clock. All this was a gift of C. F. Crocker of the well-known San Francisco family.

Holden reported on January 16, 1890, to the press the success of the Lick Observatory Eclipse Expedition at Cayenne and told how other American expeditions were not so fortunate in other localities in South America. About the same time, Miss Catherine Bruce of New York gave a sum of money to the Observatory for the employment of a computer to aid in the reduction of observations. Holden was evidently after minor donations for various purposes and succeeded in many instances. However, in one case an application for funds was refused for the reason, as one committeeman wrote that "Holden does not need our help, he only needs to write a single letter and can get all the money he calls for."

In February of 1890 a rather heavy snowfall isolated the mountain

FIGURE 12
The 36-inch lens unpacked by Captain Floyd.

for a few days and all astronomers were out to get photographs of the unusual landscape. Some of these pictures are preserved in the Lick Observatory library. Many slides were made from them and used in lecture work not only by the staff but by many professional lecturers. In the spring of that year, everyone on the mountain tried his hand at tree planting and even had hopes for flower gardens. Holden wrote

these endeavors up for the papers and told how he kept track of this extra-curricular work of the astronomers. His system of bookkeeping had some 4,000 items on cards of work done by the astronomers "not in the line of duty" representing some 8,000 hours of extra work. He also expressed himself in this article about the hopes of the community to have a school on the mountain for the children of the staff members. Children of school age kept families separated as the nearest opportunity for schooling was in San Jose. Thus, Holden's boy and the Burnham children and one or two other children from the Mt. Hamilton community were in school down near San Jose.

In one article published by Holden at that time, he stressed the need of a large reflector for the photographic work planned and called attention to the five-foot reflector of Mr. Common of London. Barnard's experimental photographs of the Milky Way with the 5-inch Willard lens made by three to four hours exposure promised good results.

During the summer months of 1890 a volunteer observer from the University of Michigan named W. W. Campbell came to the Lick Observatory for three months to study the ways and methods of a large observatory and the use of its instruments. He helped Holden in his photographic observations of the Moon and worked with Keeler on the spectroscope. He also computed one or two comet orbits. He worked day and night and his enthusiasm was appreciated by everyone.

The Mt. Hamilton Post Office

On June 1, 1890, the post office of Mt. Hamilton was permanently established and S. W. Burnham was appointed postmaster. This 4th class office has continued ever since and many of the astronomers have become the succeeding postmasters. This post office is now a characteristic part of the Lick Observatory and is unique in the annals of the U. S. Postal Service. Anyone who ever spent only two or three days on Mt. Hamilton is familiar with the part this post office plays in the life on the mountain. The names of the various postmasters are very familiar to the astronomical world. They are S. W. Burnham, A. L. Colton, C. D. Perrine, R. G. Aitken, Paul Merrill, H. D. Curtis, J. H. Moore, H. M. Jeffers, F. J. Neubauer, and N. U. Mayall. And there has been an army of assistant postmasters all appointed by the respective postmasters in charge. These men and women are now scattered all over the United States in various observatories and institutions of learning.

Final Years of Holden's Administration

In the summer of 1890, A. O. Leuschner, who should be considered one of Holden's original staff, left the mountain to accept an instructorship in mathematics in the University of California at Berkeley. About the same time, electric lights came to the mountain. The Edison Company donated a complete lighting plant consisting of a steam engine, a boiler, a dynamo, belting, mainwire, controlling wires, and a

set of storage cells. And thus the year 1890 goes into the history of the Lick Observatory without much excitement except that newspapers still had some harsh words for Holden and there was talk of the resignation of some staff members.

Early in 1891 the driving clock of the 36-inch was still wound by hand every two hours when the telescope was in use. Later this was done by a Pelton water wheel, and later still by an electric motor.

That year Keeler's radial velocity observation on Arcturus yielded results with the probable error of ± 0.2 km/sec, a remarkable accuracy unsurpassed in modern photographic spectroscopic work. The summer before he had been assisted in these difficult visual observations by W. W. Campbell of Michigan Observatory and thus Campbell entered his long career as a radial velocity observer.

Early in 1891 Barnard received the Donohoe Comet Medal from the Astronomical Society of the Pacific for his fifteenth comet discovery.

In May, Keeler resigned from the staff of the Lick Observatory. The newspapers made much of this event unjustly, blaming Holden as the cause. Keeler was appointed Professor of Astronomy in the Northwestern University of Pennsylvania and Director of the Allegheny Observatory to succeed his friend, Langley, the former Director. Keeler resigned simply because he was offered twice the salary he received at the Lick, he wanted to get married, and life for a young couple on the mountain was too difficult as there was no suitable housing available.

W. W. Campbell was appointed astronomer in the Lick Observatory on June 1, 1891, to succeed Keeler and this partially reconciled the California newspapers to the loss of Keeler. Michelson came to the Lick and measured the diameter of Jupiter's satellites, with an interferometer of his own design, assisted by Campbell. Dr. Henry Crew was appointed astronomer in the Lick Observatory on July 14, 1891, coming from the Physics Department of Haverford College. Holden had in mind to have Campbell and Crew look after the spectroscopic work. That same summer a small building with a 10-foot dome was built south of the Huyghens reservoir to house the Crocker photographic telescope.

A severe forest fire raged on the mountain from July 21 to 28, 1891. The astronomers, under the charge of Schaeberle, fought the fire for several days and nights and finally succeeded in controlling it. Holden, in a newspaper description of the forest fire, praised his staff for their work. In a more poetic than realistic statement, he said that such experiences were not unusual for faculty members. He implied that intellectuals in such emergencies are equal to anyone and cited the siege of Metz where seven professors of Sanscrit were in the Germany Army. Another item of interest for Californians in the same article is an account by Holden of a visit to the Lick Observatory by David Starr Jordan, the elected President of Leland Stanford Junior University.

On November 17, 1891, a serious accident occurred on the road to

Mt. Hamilton about 10 miles from San Jose. A rancher, by the name of Daniel S. Lundy, driving a heavy wagon up the road, got caught by low-hanging telephone wires which knocked him from the seat so that he was killed. The coroner's jury decided the death was due to negligence of the telephone company. The company stated the telephone line was owned by the Lick Observatory and thus the Regents of the University were responsible. A lengthy trial in which the relatives of Mr. Lundy claimed high damages resulted in favor of the plaintiff. An appeal to the State Supreme Court reversed the case in favor of Holden and the Regents. The whole matter is of little importance now, but at that time it received much attention by the press, and Holden, as usual, became the target of much criticism. The Regents felt the necessity of having the transcript of the trial published in printed form of about 650 pages for general distribution. The whole matter was soon forgotten, but the reason for bringing it into this history is to show that the press continued its unfriendly attitude.

Early in 1892 Andrew Carnegie and Andrew W. White were guests at the Lick Observatory for two days. Immediately after this visit, Holden, in an open letter to the press, showed in print his original plans for the Lick Observatory which he and Newcomb made in 1874. He claimed the original sketches were furnished to the Lick Trust in 1874, but got lost. When he met Floyd in London, in 1876, Floyd had no knowledge of this memorandum. Holden furnished him with a copy from his own notes from which the original had been made. Mr. S. E. Todd, the architect in Washington, used these plans in 1879 to draw the final plans for the Lick Observatory. Holden was very sensitive about this matter, for he told of the same episode on two later occasions, including it in his letter of resignation to the Regents some five years later. Rumors in the spring of 1892 had it that several members of the staff were to resign, and the fact was that Burnham did resign on June 14, 1892. The newspapers had many columns about his great loss to the University and the State of California. Some papers openly asked to have Holden discharged and Burnham made Director of the Lick Observatory. In any case, the blame was placed on Holden, and one can only say again, unjustly. For Holden always let Burnham have his way and was eager to have him get the academic recognition so dear to the heart of a professional faculty member. The fact was that Burnham could not see any sense to his looking after the two establishments he had to maintain, one here on the mountain, the other for his family in an Jose where his children attended school. In short, it was a money question. He always could go back to work as clerk of the U. S. District and Circuit Court in Chicago at a much higher salary than he received at the Lick Observatory as an astronomer.

Holden received that year sufficient funds for a paid fellowship. Mrs. Phoebe Hearst who gave so much to the University was the donor and Mr. S. D. Townley of the University of Wisconsin was appointed as

Phoebe Hearst Fellow in Astronomy on July 1, 1892. Holden published the list of names of the graduate students and, among them, that of W. J. Hussey appeared, who was an Assistant Professor in the nearby Stanford University.

Another resignation that summer was that of Dr. Henry Crew, who came to the Lick Observatory only the year before. This again gave the newspapers an opportunity to attack Holden. Professor Crew was a married man and the living conditions and housing on Mt. Hamilton were not suitable. Moreover, he had an appointment awaiting him at the Northwestern University as Professor of Physics at more than double his former salary. As in the case of Burnham, reporters were lying in wait to interview Crew on his departure for the east, hoping to get some detailed information about the why and wherefore of these resignations. The guarded replies the reporters received to their many questions were always wrongly interpreted.

When Mars was in opposition that year, a telephone call from the editor of one of the larger San Francisco papers to Holden made some inquiries about the canals of Mars. Holden's reply was evidently misunderstood, or not quite clear, since the editor sent telegrams to all leading observatories asking the respective directors to confirm Holden's opinion. This action was much resented by Holden, and he so expressed himself again in open letters.

The Crossley Reflector

There appeared an advertisement on the back cover of the February, 1892, number of *Astronomy and Astrophysics*, which offered for sale a 3-foot mirror and its mounting, also the dome and some minor equipment. No price was quoted and the name of the owner was not known to anyone. It turned out, after inquiry by Holden, that the owner was Mr. Edward Crossley of Halifax, England, an amateur astronomer, who purchased this telescope from A. A. Common in 1885, but found the climatic conditions of Halifax unsatisfactory for observing. He wished to dispose of this observatory. Also, the signed name in the advertisement above was that of the astronomer he had engaged. Holden let no grass grow over this matter. At once, he interested some people in this opportunity of securing for the Lick Observatory what would then be the largest reflector in the U. S. He made plans for location and housing and for suitable additional equipment for such an instrument. Holden persuaded Mr. Crossley to donate the whole equipment to the Lick Observatory, promising in exchange that the telescope would be known as the "Crossley Reflector," and that the expenses for dismounting and packing the telescope and dome in England and shipping all to California would be borne by the Regents of the University. Thus the Crossley reflector got its start in 1892.

The graduate school of astronomy at Mt. Hamilton was in full swing during the summer of 1892. Six names are listed, three of them are candidates for the doctor's degree. None of the three candidates ever

took the degree here, but all three did later in some other institution. The time was not ripe for such scholastic training at the Lick Observatory. None of the staff took sufficient time out from his own interests to guide or direct a young graduate toward a definite problem of investigation. It still took several years before the first candidate received the doctor's degree from the Lick Astronomical Department.

Discovery of the Fifth Satellite of Jupiter

On September 9, 1892, young Barnard made the discovery of the fifth satellite of Jupiter. The telegram announcing this epoch-making discovery went out on September 11, 1892, and quite naturally, much space was devoted to this event and to its discoverer. Barnard became a hero overnight. He later received the Lalande prize of the Paris Academy of Sciences for this discovery. As always in such cases, there were some who claimed they saw this satellite previous to Barnard's announcements. Among these was a Mr. Cogley of Washington, D. C., a lawyer by profession and an ardent amateur astronomer by choice. This gentleman owned a five-inch refractor and claimed to have seen this fifth moon of Jupiter on June 8, 1888, at 8:15 P.M. His records were in good order and he submitted them to the Naval Observatory. The astronomers there, after checking his records carefully, decided that Mr. Cogley had observed the faint star "47 Librae" which happened to be in the same field as Jupiter at the time when Cogley observed the planet. Burnham, in Chicago, showed proudly to his friends a telegram from his young friend, Barnard, which read: Mt. Hamilton Observatory, September 12, 1892. E.E.B. sends greeting to S.W.B. with a fifth satellite to Jupiter of the thirteenth magnitude. Period 11 hours and 36 minutes, distance from center 112,400 miles." Burnham told the press "The discovery of this satellite is the greatest astronomical achievement of the century and will cause the world of science to ring."

Shortly after this, a report from Chicago stated that "most likely" Barnard will be called to the University of Chicago, since Mr. Yerkes assured this institution that he was willing to give $500,000 toward an observatory second to none. There was also some talk of having a 45-inch objective made and placed at the disposal of Burnham and Barnard.

Radial Velocity Program

During 1892 Campbell had made experiments with the spectroscope by replacing the eyepiece and micrometer by a home-made camera. The preliminary results were promising and he made plans for a spectrograph and an observing program for radial velocity investigation. Schaeberle made preparation for another eclipse expedition, this time to Chile for the eclipse of the sun in April, 1893.

The spring of 1893 was full of minor events which made Holden more unpopular. *The Occident,* a student publication of the University

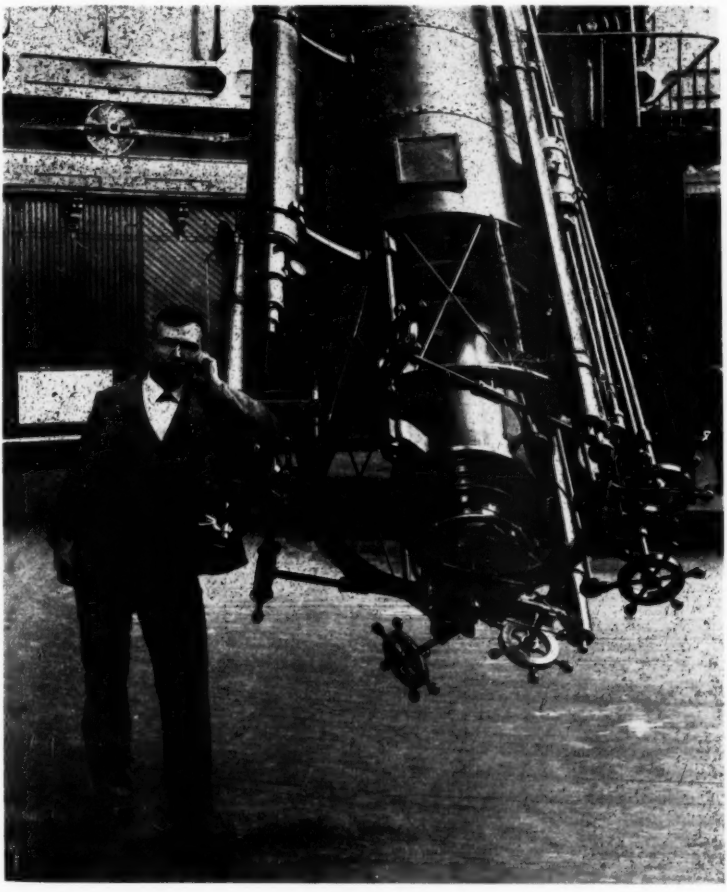

FIGURE 13

Edward E. Barnard and the observing end of the 36-inch refractor. Photograph taken about the time of the discovery of the fifth satellite of Jupiter.

of California, told of a trip to Mt. Hamilton by faculty members and students which was to be the event of the year. The trip from Berkeley to the Observatory and back then took three full days and was rather expensive as far as the students were concerned. Like all such excursions some found great pleasure in what they saw and whom they met but the great majority of the party was rather disappointed, found the reception cold, and what they saw too hurriedly shown. Holden had as dinner guests the young ladies who listened spellbound during the whole dinner to their host. The boys were left outside, and like all

normal boys, were getting hungrier as time of waiting continued. By nine o'clock Holden insisted on closing the Observatory to them. Anyhow, all this was written up in *The Occident* praising young Campbell who was on the 36-inch that night for his kindness and willingness to make their journey interesting, but blaming Holden for his abrupt manners. Other papers wrote this visit up and many public letters appeared in the press, some by Berkeley faculty members and some by Holden on the useless defensive.

Campbell received the happy news that Mr. D. O. Mills gave $1,000 to the Regents for a spectrograph and so the birth of the famous Mills spectrograph must be dated April 22, 1893.

On Commencement Day at the University of California in 1893, the honorary degree of Doctor of Science was conferred upon Keeler, who was now the Director of the Allegheny Observatory, and also upon Professor L. Weineck, of the University of Prague, for his delineation of Holden's photographs of the Moon.

Two men now came to the Lick Observatory who played a great part in the history of the mountain, Tucker and Colton. The first, R. H. Tucker, took charge of the meridian circle and supervised the clocks. He served in that capacity for 33 years. He resided on the mountain until July, 1926, when he retired from the Observatory and took up residence in Palo Alto. Only a short while ago he celebrated his ninetieth birthday in good health, receiving the attention of astronomers from all parts of the world, and visits from many on that memorable day. He and Schaeberle formed the so-called senior mess, a boarding establishment all their own, which set the scale of social distinction for the younger members of the staff. Both gentlemen were men of their time in academic life and sort of arbiters of the finer social customs. The second man appointed that year was A. L. Colton of Washington, D. C. He was formerly a student of astronomy in the University of Michigan, but recently private secretary to M. W. Harrington of the U. S. Weather Bureau. Holden assigned to him all photographic work, especially the developing of plates. He was a good photographer. What became of Mr. Colton, after he left the Lick Observatory some years later, the records here do not tell us, but, no doubt, he went into a different field of work.

At the time the new appointments were made, it was also announced that the Regents requested Barnard to make a tour of inspection of the leading observatories of Europe in the interest of astronomical science, and granted him six months leave of absence with full pay. The *San Francisco Examiner* came out with large headlines: "Barnard will never come back."

C. D. Perrine came to the Lick Observatory in 1893 as Secretary, hoping for an opportunity to use the astronomical instruments to satisfy his true amateur's desire for making discoveries. He volunteered for the observational work of taking daily photographs of the Sun with

the photoheliograph. The objective of this instrument had an aperture of 5 inches and focal length of 40 feet. It was this lens that Schaeberle used so successfully on his eclipse expeditions. The number of the plates taken with this instrument by Perrine is very large, but there never was time or money to reduce the observations systematically and thus the plates piled up. Perrine also worked with other instruments and was made an assistant astronomer. The great number of comets discovered by him tell the story of his enthusiasm.

The year 1894 brought many visitors to the Lick Observatory judging from the signatures in the Visitors Register. Among the many distinguished names signed there, as guests of Holden, is Ex-President Harrison on April 12 and 13.

Campbell now worked with his spectrographs, using the 36-inch refractor three nights a week and was also on the 36-inch on visitors' nights. This was certainly a heavy schedule. Two new brick residences were built that year, one for Barnard, the other for Campbell; Campbell occupied this home until 1935. During the summer of 1894 a number of graduate students were on the mountain, among them Robert G. Aitken, Professor of Mathematics in the University of the Pacific in San Jose, which is now the College of the Pacific in Stockton. As far as the record shows, that year saw the first woman graduate student at the Lick Observatory, Miss Mary Edwards, a B.A. from Stanford.

In the early part of 1895, the worst snow storm on record occurred from January 15 to 23 when neither the stage nor anyone could get through.

On April 4, 1895, Holden proudly informed the public that the Crossley Reflector would be sent to Mt. Hamilton. Holden asked for subscription of money to pay for the transportation of the equipment and the erection of the dome. He persuaded the Wells Fargo Express Company and the Southern Pacific R. R. to donate the freight charges and even had money enough to pay for the housing of the instrument. During the early months of 1895 the preparation of the building site for the Crossley Reflector was underway. Holden's plan and ambition to have the Lick Observatory the largest and best equipped observatory in the world was nearer realization. The word came from England that the instrument and dome would soon be ready for shipment. The rumor again started that more resignations from the staff were to take place and the papers frequently mentioned Barnard's name in this connection. No definite reason can be found now why all this newspaper talk continued. Holden tried to increase his staff and had requested the Regents to have two more astronomers appointed on his recommendation. His requests were turned down for the always good reason that there was no money available, but possibilities for more appointments within a year were bright.

For graduate students on the mountain of the summer of 1895

Holden had three names listed, R. G. Aitken, M.A., William H. Wright, B.S., a candidate for the M.S. degree, and J. M. Brosius from Napa College. A cablegram from Liverpool dated June 28, 1895, told of the departure of the Crossley mirror and dome for Mt. Hamilton.

W. J. Hussey, coming from Stanford University, to the Lick Observatory was appointed astronomer and R. G. Aitken was appointed assistant astronomer on August 1, 1895. Professor Hussey was to take charge of the installation of the Crossley Reflector. The population of the community became larger and the need of a school to look after the children came more to the front. The county school authorities felt that a school could be maintained if a suitable building were available and if plans could be made to house and board the teacher in charge.

By 1896 Perrine had discovered several comets and received the A.S.P. comet medal that year. Preparation for the coming solar eclipse was made. Again Mr. C. F. Crocker offered to defray the expenses for one or two observers to be sent to Japan. Brashear made a six-inch photographic lens having a focal length of about 40 feet for this eclipse. The press was informed by Holden that Schaeberle was to be in charge of this eclipse expedition, but for the first and only time Schaeberle's eclipse career was frustrated by bad weather.

The winter of 1895-1896 was very mild and much outdoor work could be done. John McDonald constructed the building and erected the dome for the Crossley Reflector practically all by himself. By June, 1896, the Crossley mirror was mounted and tests begun.

Early in 1896 Holden received the Order of Bolivar, III Class, for his services in science and was appointed to be a member of the Board of Visitors of the U. S. Naval Academy at Annapolis. In the "Gay Nineties" such honors were written up in the press in very flamboyant headlines and long paragraphs always referred to the recipient in glowing terms, to the charms of his wife and her distinguished relations three or four generations back. For years such publicity was almost essential for a scholar to "get anywhere." But all such academic honors helped Holden little in gaining a better foothold in his administrative work.

Meanwhile, the Yerkes Observatory was completed, and the team of Burnham and Barnard was appointed on its astronomical staff by G. E. Hale, the Director.

Also that year Miss Bruce contributed toward a comet seeker and a visual photometer for use with the 36-inch refractor. The University of the Pacific conferred the degree of Doctor of Science upon Holden. In his ninth report as the Director of the Lick Observatory to the President of the University of California, Holden mentioned the fund which he raised for the Crossley Reflector as $5,085.00. Hussey was placed in charge of this instrument, and he designed a driving clock for it which was constructed on the mountain by the instrument maker, Mr. William Pauli. Campbell was deeply involved in radial velocity

FIGURE 14
John M. Schaeberle and the 36-inch lens in mounting.

work and planned an expedition to some spot in South America for observing the brighter stars of the Southern Hemisphere which he could not reach from Mt. Hamilton. William H. Wright was appointed Assistant Astronomer at the Lick Observatory on July 13, 1897, and the University Fellowships were established. Preparations were begun for the coming solar eclipse of January 21 and 22 in 1898. This time

Campbell was placed in charge and he and Mrs. Campbell left for India to observe the eclipse there. So the prospects were bright, although a great benefactor of the Lick Observatory died that year, Mr. Charles F. Crocker.

The life of the community on the mountain seemed to be under a nervous tension. Even casual visitors noted this and rumors of more resignations floated about. Not one was willing to say, perhaps no one knew just what was the cause of this tension. As always everywhere, there were conflicting personalities, and in a small community as isolated as the mountain was then, these became more conspicuous. It will always be a strange fact that Holden never did arouse in his appointees a sense of loyalty except in only one case. As judged from the correspondence of that time, he did all a man could do for his staff. He was certainly a financial asset to the Observatory and he helped generously everyone of his staff to get equipment which could not be gotten through the budget of the University. He was perhaps a little too self-centered in his own work, that of writing about astronomy in general. As one severe critic once publically stated, "he writes more about astronomy and says less." He may have overlooked the enormous strides the science had made during his own time as an administrator. His problem as director became more and more onerous as the normal increase in families living on the mountain, growing children and their pets, all added to his overburdened responsibilities. For children and dogs cannot be ruled in a military manner.

All this came to a boiling point with the resignation of Mr. Colton, the assistant astronomer, directly under Holden's sphere of activity. Mr. Colton expressed himself rather freely in his letter of resignation to the Regents and perhaps more freely to newspaper reporters. All of this again set up a reaction in the press unfavorable to Holden. Holden now felt that the best thing for all concerned was to resign and his resignation was accepted by the Regents as of January 1, 1898, although Holden had been away from the mountain several months before that date.

Schaeberle was made the Acting Director the same day Holden's resignation took effect. Campbell was on his way home from India, *via* the Suez Canal and Europe and was expected back by June, 1898. The eclipse had been successfully observed and this added prestige to Campbell's reputation as an astronomer. There was some talk in the daily press of his being made the next director. Davidson was also spoken of, in spite of the fact that the gentleman was over 70 years old. When the Regents met for the purpose of electing a Director for the Lick Observatory, all Regents were present including the Governor of the State. On the first ballot, the votes were evenly divided between Keeler and Davidson and there were two for Schaeberle. The second vote was unanimous for Keeler and everyone was very pleased with the selection. The Regents made Davidson Professor of Astronomy in

Berkeley. Keeler came to the Lick Observatory on June 1, 1898, and on the same day Campbell returned from the Eclipse Expedition to India having circled the globe on his return journey. On Commencement Day at the University, May 18, 1898, Schaeberle received the LL.D. degree from the University and he resigned. He was the last member of the original staff with which the Lick Observatory started on June 1, 1888. The Regents urged Schaeberle to withdraw his resignation and offered him a year's leave of absence with full pay. But he felt he could not accept and also felt perfectly satisfied. In justice to Keeler's election, he stated in a public announcement that, had the Regents elected any other man as director, his action would have been exactly the same.

Keeler, on assuming the directorship of the Lick Observatory on June 1, 1898, devoted his time to putting the Crossley Reflector in perfect condition for direct photographic observations and he succeeded remarkably well as every astronomer now knows. In the same year he received the Rumford Medal of the American Academy of Sciences. He was elected to be a member of the National Academy of Sciences and received the Henry Draper Medal.

Mr. H. T. Phelps, Chairman of the Lick Observatory Committee of the Board of Regents, died at his home at San Carlos, California, from injuries inflicted by a reckless bicycle rider. He was the great friend of the Observatory among the Regents from the very start. He had been a successful business man and was once a Member of Congress during the Civil War.

In 1899 Coddington and Crawford were the Lick Observatory Fellows and resided on the mountain. Campbell's preparations for the Southern Expedition got into full swing and Mr. D. O. Mills offered to defray the expenses for two years in South America.

Another total solar eclipse was in the offing, this time the one in Georgia in 1900. Campbell and Perrine made up this eclipse party and they observed the sun in Thomaston, Georgia. William H. Crocker of San Francisco met the expenses this time. It was the first of the nine Lick Observatory expeditions which followed, all supported by him.

An interesting article dated April 12, 1900, in *Nature* (London) told of the development of astronomy in America. It said that America was in possession of the finest observatories, manned by observers of the greatest skill, who devoted themselves untiringly to the advancement of the old science. This held for every branch of theoretical and practical astronomy, especially in the field of astronomical physics. The article spoke highly of the work at the Lick, calling special attention to Campbell's work in the photography of the spectra of nebulae and bright line stars, and to the radial velocity program under progress. Leuschner that year was made the director of the Students Observatory in Berkeley, now an independent astronomical department instead of, as formerly, part of Civil Engineering. From that time on, the Students

Observatory under Leuschner played its great part in the development of astronomers and astronomy in the United States.

Then suddenly and quite unexpectedly, Keeler died in San Francisco on August 12, 1900. And so the most prominent scientist of the first staff passed into history. His reputation as one of America's great astronomers is as high today as it was on the day of his death. And with this sad event, which was felt by all, here on the mountain and everywhere in the astronomical world, this part of the Short History of Lick Observatory comes to an end. Within a few days after Keeler's death, Campbell was elected director. His long career as administrator and his well-known astronomical success are too recent to be spoken of as history.

Lick Observatory, Mt. Hamilton, California.

Alexander Wilson, M.D.*

A University Astronomer of Eighteenth Century Scotland

By ANGUS ARMITAGE, F.R.A.S.

During the eighteenth century there occurred in Scotland a cultural revival which bore fruit over wide fields of thought and practice. The Union with England in 1707 brought a growing measure of trade and prosperity to the northern kingdom and widened its intellectual horizon. As the century drew on, there shone forth in the Scottish firmament such bright stars as Colin Maclaurin the mathematician, David Hume the empirical philosopher, Adam Smith the founder of political economy, James Hutton the pioneer of modern geology, John Hunter the anatomist, Joseph Black the discoverer of specific and latent heats, and James Watt the improver of the steam-engine. These men exemplified only a few aspects of a rich and complex movement. Most of them, at some time or other in their lives, were connected with the old College of Glasgow, which, along with the other Scottish Universities, was at this period only just emerging from a largely mediaeval condition of things. The practice still survived of putting a class of students under the tuition of a *regent* who was expected to take them through their whole course in all subjects up to graduation level. But now this system was giving place to the modern practice of entrusting the teaching of each subject to a specialist professor. The circumstances which led up to the establishment of a Chair of Practical Astronomy at Glasgow, and the career of its earliest occupant, Alexander Wilson, are of some historic interest. Wilson was not of the intellectual stature of his great contemporaries above named, but he has some claim on our attention through his preoccupation with two matters much in the thoughts of astronomers today—the nature of sunspots, and the revolution of the stars about a common centre.

*Ninth paper in the series "Papers on Historical Astronomy."

Alexander Wilson was born in 1714 at the Scottish University city of St. Andrews, where his father, Patrick Wilson, was town clerk.[1] Entering college young, as the custom then was, he excelled in the traditional branches of learning, and graduated M.A. of St. Andrews at the age of eighteen. However, he also found time to cultivate a taste for physical science, particularly astronomy and optics, and he managed to acquire, almost unaided, considerable skill in drawing, engraving, and modelling. Having chosen medicine as a profession, Wilson was apprenticed to a local surgeon and apothecary. About this time George Martine (a physician whose experiments on heat stimulated the researches of Joseph Black) encouraged him to take up glass-blowing as a hobby and to become proficient in making and graduating accurate thermometers. Wilson contrived to make these instruments easier to read by flattening the bore of the tubes so that the mercury appeared as a broad ribbon.

Already in those days many Scotsmen were taking the road to England in search of fortune, and quite a number of the fashionable London doctors hailed from north of the Border. In 1737 Wilson himself migrated to the English metropolis; there he found employment as assistant to a French surgeon, a political refugee, who received him into his family circle. Among the Scottish colony in London, Wilson found a friend in Dr. Charles Stewart, who was the private physician of Archibald Campbell, Earl of Islay, the brother and heir of the Duke of Argyll. Stewart introduced Wilson to Lord Islay himself, who invited the young Scotsman to see his fine collection of astronomical instruments, accepted several thermometers from him, and, as we shall see, subsequently played a decisive part in opening the way for him to become a professional astronomer.

However, the next stage in Wilson's varied career was determined by a chance visit which he paid to a London type-foundry. What he saw there suggested to him the possibility of improving upon the existing method of manufacturing metal types.[2] He shared his ideas with a fellow-townsman named Bain, and the two young men threw up their professions and went into partnership to exploit the invention, first in London and later at St. Andrews, where they established a type-foundry. They ran into unexpected difficulties, and were forced to revert to the traditional technique of type-making. The business flourished; a larger factory was erected near Glasgow, and a branch was opened in Dublin, of which it was decided, by a throw of the dice, that Bain should take charge while Wilson remained in Scotland. At that period the Glasgow University Printers were Robert and Andrew Foulis, who were to achieve lasting renown for their craftsmanship. It was not long before Wilson was brought into business relations with the Foulis brothers, his artistic talents finding scope in the design and execution of Greek types for the magnificent editions of the classics which were then being published by the University scholars. In due

course he became official type-founder to the College of Glasgow with premises in the old College buildings, which have now completely passed away. During his hours of leisure, Wilson indulged his boyish interest in astronomy, the foundry affording excellent facilities for alloying and casting metal discs which he ground and polished to furnish specula for small reflecting telescopes.

It was at this period that Wilson's scientific interests brought him into close friendship with a gifted young amateur, Thomas Melvill, of whom there might have been much more to tell if early death had not removed him. In 1748 and the following year Melvill was up at St. Andrews taking a divinity course, and he co-operated with Wilson in a variety of scientific ventures, notably in investigating the temperatures of the atmosphere at what were then regarded as great heights above the Earth's surface. In those days there were no sounding-balloons with self-recording instruments; so the two investigators sent up a long train of kites attached to one another in a series by lengths of string. To the uppermost kite (which was often lost to view in the clouds) a thermometer was attached; this was released by means of a time-fuse at a prearranged instant, and it fell to earth (its fall being broken by an attached tassell of paper) where its indication was hastily read, and the low temperatures supposed to prevail at such altitudes were thus confirmed.

Melvill was stimulated by his friendship with Wilson to undertake various other researches. He deserves to be remembered as a pioneer of spectrum analysis.[3] Observing through a prism an aperture illuminated by incandescent sea-salt, he noticed that the image was sharply formed in yellow light: "Because the hole appears through the prism quite circular and uniform in colour, the bright yellow which prevails so much over the other colours must be of one determined degree of refrangibility,"[4] being, as we now know, the characteristic radiation of sodium. Melvill went on to suggest that differently coloured rays of light might travel at different speeds even through empty space, and suffer different degrees of aberration, forming, in fact, a sort of *aberration spectrum*. From the same cause, the eclipse of a satellite of Jupiter should be attended by colour-effects, the object appearing just before extinction in the colour which takes the longest time to reach us—a phenomenon which the contemporary astronomer James Short sought for in vain.[5] Melvill died in December, 1753, at the age of twenty-seven; he thus missed seeing his friend enter the ranks of professional astronomers, which came about through circumstances now to be related.

At Glasgow University, astronomy was studied as a branch of physics (or natural philosophy) by candidates for the M.A. degree. Several telescopes were available to the students for practical work, one of them, an eight-foot refractor, having been acquired in 1693. However, in 1757, a new chapter opened with the founding of an observatory to house and utilize a valuable collection of astronomical in-

struments which had been bequeathed to the University by one Alexander Macfarlane, a wealthy Jamaica merchant.[6] The Macfarlane Observatory was erected in the grounds of the old College, and the instruments were installed there after having been first put in order by James Watt in his capacity of mathematical instrument maker to the University. Tobias Smollett the novelist, an old Glasgow medical student and a friend of Macfarlane's brother, refers to the observatory and its stock of instruments in his "Humphrey Clinker." Through the good offices of Wilson's old friend, formerly Lord Islay, who, in 1743, had succeeded to the title of Duke of Argyll, a Chair of Practical Astronomy was in 1760 established by royal warrant, and Alexander Wilson was chosen as its first occupant and as Director of the new observatory. Shortly afterwards he was awarded the honorary degree of M.D. by his old University of St. Andrews. He handed over the type-foundry to his two eldest sons under whom it prospered. At the observatory Wilson continued his efforts to improve the reflecting telescope, particularly by choosing a suitable metallic alloy for the composition of the speculum, and by giving to the latter a paraboloidal figure.

Wilson possessed almost perfect eyesight, and his trade had taught him to appreciate fine details of design. He was drawn to study the behaviour of sunspots, and to formuate the theory of their structure with which his name is usually associated in the text-books, and which he explained in a paper read before the Royal Society in April, 1773.[7] At that period it was the practice to observe sunspots by projecting an image of the Sun on to a white screen; but Wilson scrutinized them directly through a telescope provided with a dark glass.

It was in November, 1769, while observing day after day an unusually large spot, that Wilson noticed the progressive contraction, and eventual disappearance, of the penumbra (the shaded border) of the spot on the side nearest to the center of the solar disc, as the spot approached the western limb of the Sun. At the same time the umbra (the dark nucleus) was seen to contract in a characteristic manner and finally to disappear. He formed the opinion that "the central part or nucleus of this spot was beneath the level of the Sun's spherical surface; and that the shady zone or umbra" (what we call the *penumbra*), "which surrounded it, might be nothing else but the shelving sides of the luminous matter of the Sun, reaching from his surface in every direction down to the nucleus; for, upon this supposition, I perceived that a just account could be given of the changes . . . above described . . . and further, that the sudden alterations now discernible in the figure of the nucleus were occasioned by some part of it also being hid by the interposition of the edge of the excavation between the nucleus and the eye."[8] Wilson was confirmed in his opinion by observing that when the same spot appeared again at the Sun's eastern limb the following month, it was now the turn of the *western* side of the penumbra (nearest the centre of the disc) to be invisible. He drew further support

from the observed behaviour of other spots in subsequent years, and he even sought to deduce geometrically from his observations the depth of the excavation constituting the spot. He concludes his paper with several Queries: "Is it not reasonable to think that the great and stupendous body of the Sun is made up of two kinds of matter, very different in their qualities; that by far the greater part is solid and dark; and that this immense and dark globe is encompassed with a thin covering of that resplendent substance from which the Sun would seem to derive the whole of his vivifying heat and energy?"[9] A spot might then result from the removal of part of this luminous covering through the working of some sort of gas generated within the dark globe. Wilson also expounded his theory in a prize Latin essay which was crowned by the Royal Academy of Science of Copenhagen in 1772.

In his memoir on sunspots of 1776, Lalande, the great French astronomer, objected that the changes observed in the appearance of a spot as it crossed the Sun's disc did not invariably accord with Wilson's theory.[10] He preferred to regard the nucleus, or umbra, of a sunspot as a dark, solid mass projecting from the flux of liquid, fiery matter covering the surface of the Sun, just as a rock projects from the sea at low tide; the penumbra then represented the surrounding shallows.

In the course of his reply to Lalande,[11] Wilson described how he had constructed a model of the Sun consisting of a spherical core of wood with a coating of glue and whiting in which he had cut sunspot cavities and blackened their floors with ink. He used to view this model from a distance, measuring up the spots and their penumbras with a micrometer as the sphere was slowly turned round upon a metal axle.

It long remained a matter of dispute, even among highly experienced observers of sunspots, whether their results afforded any significant support to Wilson's hypothesis. The generally accepted modern view of the typical spot as a shallow, funnel-shaped depression is, of course, related to an entirely different conception of the physical nature of sunspots from that prevailing in the eighteenth century.

In the same year, 1769, in which Wilson observed the great sunspot, there occurred an historic transit of Venus. Wilson and his Glasgow colleagues prepared to time the passages of the planet across the Sun's limb. For fear the smoke of the city should spoil the observations "an advertisement was put in the newspaper, begging the inhabitants, in cases where it would not be very inconvenient, to put out their fires from three o'clock that afternoon till sun-setting; the politeness of the inhabitants of Glasgow in complying with this request was far greater than could well be expected."[12] However, the numerical results exhibited a discouraging diversity owing to unexpected optical complications which were to become only too familiar to observers of such transits. In a later volume of the *Philosophical Transactions*[13] Wilson suggested a method of minimizing the effective thickness of micrometer wires, etc., in telescopes, namely, by taking lengths of the thinnest silver wire

obtainable, flattening these under pressure, and then attaching them in the focal plane so that they were presented edgewise to the observer's eye. This, like all Wilson's other contributions to the *Transactions,* was "communicated" to the Royal Society by Nevil Maskelyne, the Astronomer Royal, with whom he corresponded extensively.

Early in 1777 Alexander Wilson and his son, Patrick, found themselves discussing why the stars do not fall on to one another under their mutual gravitation. Their conclusions were published later the same year (as "hints," not as a "rash hypothesis") in a short, anonymous pamphlet.[14] Wilson's way of solving the problem was to propound another: What hinders the planets from falling together to form with the Sun a single central mass? The solution obviously lay in the "projectile forces" of the planets which maintain them in "periodical motion" about the central luminary. Wilson invoked the same agency to account for the preservation of the system of the stars: "If Periodical Motion seems thus necessary to the preservation of a small assemblage of bodies, and if Newton's law presents to us the whole Host of Heaven as one great assemblage affected by gravitation, it seems necessary still to have recourse to Periodical Motion in seeking after the establishment of this Grand Universal System." May not then the Sun and his train be regarded as "but a faint representation of that Grand System of the Universe round whose centre this Solar System of ours, and an inconceivable multitude of others like to it, do in reality revolve according to the Law of Gravitation?" Both reason and analogy support this view, but "appeal may be made to arguments still more direct," namely, to the proper motions of stars announced by Halley in 1718 and confirmed by other astronomers. As if foreseeing the achievements of Lindblad and Oort, Wilson concludes: "Let posterity therefore determine how far the observed laws of these celestial motions shall favour these hints of One Grand Universal System." Were it not for the periodical motion of the stars about a common centre, "the whole glory of Nature would terminate in one universal ruin. But a supposition so injurious to the wisdom and to the over-ruling power of the Deity must be rejected as derogatory in the highest degree."

It is of interest to compare these words with those of another minor astronomer of the eighteenth century, Thomas Wright of Durham, in his "Original Theory," published just two hundred years ago.[15] Wright speaks of "the projectile, or centrifugal Force, which not only preserves [the stars] in their Orbits, but prevents them from rushing all together, by the common universal Law of Gravity," etc.[16] Was Wilson acquainted with Wright's little-known work published twenty-seven years before his own? Even Sir William Herschel makes no reference in his writings to the pioneer work of Wright; and he seems not to have seen Wilson's tract until he received a copy from the author only a few days before his own classic paper "On the Proper Motion of the Sun and Solar System" was read (March 6, 1783) to the Royal Society. Her-

schel acknowledged the gift in a letter to Wilson dated March 3, 1783. Addressing the Glasgow astronomer as "a Gentleman so dear to all lovers of science and to Astronomers in particular," Herchel continues: "I was apprehensive that what I had wrote on the motion of the Solar System might be thought too much out of the way to deserve the notice of Astronomers; but since I have seen the contents of the valuable tract you have sent me, I am not without hopes that what I have said will be received, by a few at least, with no disapprobation; and if you should be one of that number, I shall think myself particularly flattered."[17] Herschel also referred to Wilson's tract in a note appended to his paper when it was printed in the *Philosophical Transactions* of 1783.

It was in that same year that Alexander Wilson resigned from his Glasgow Chair owing to advancing age, and was succeeded by his son and assistant, Patrick Wilson (1743-1811). The veteran astronomer lived in retirement among his family for three more years, and passed peacefully away on October 16, 1786. Herschel found in Patrick Wilson a faithful friend and correspondent. After Patrick, in his turn, had relinquished the Glasgow Chair in 1798 and settled in London, he and his sister were welcome guests of the Herschels at Slough, where the two astronomers amicably observed sunspots together.

Meanwhile, the useful activities of the old Macfarlane Observatory continued to the middle of the nineteenth century. It was there that William Thomson, later Lord Kelvin, learned to take star-transits. However, by that time, the site was becoming hemmed in with high buildings, and the atmosphere polluted by smoke. Accordingly, in 1845, the authorities took over an observatory founded some years before by a private society at Horselethill, which at that time lay some way out from Glasgow but now forms part of the western suburbs of the city. Thither the instruments were transported, and there the astronomical work of the University is still carried on.

References

[1] An obituary of Wilson was read before the Royal Society of Edinburgh in 1789 by his son and successor, Patrick Wilson; it was published much later in the *Transactions* of that Society (1826, x, 279 ff.).

[2] T. C. Hansard: *Typographia*, London, 1825, pp. 362 ff.

[3] *Essays and Observations, Physical and Literary*, read before a Society in Edinburgh and published by them, Vol. ii (1766), pp. 12 ff. Reprinted in full in *Journal of the Royal Astron. Soc. of Canada*, 1914, viii, 229 ff.

[4] *op. cit.*, p. 35.

[5] *Phil. Trans.*, 1753, xlviii, 268 ff.

[6] See D. Murray: "Memories of the Old College of Glasgow," Glasgow, 1927, pp. 260 ff.

[7] *Phil. Trans.*, 1774, lxiv, 1 ff.

[8] *ibid.*, p. 8 f.

[9] *ibid.*, p. 20.

[10] *Hist. de l'Acad. Roy. des Sciences. Année* 1776 (1779), *Mém. de Math. et de Phys.*, pp. 457 ff.

[11] *Phil. Trans.*, 1783, lxxiii, 144 ff.

[12] *Phil. Trans.*, 1769, lix, 334.

[13] *Phil. Trans.*, 1774, lxiv, 105.

[14] "Thoughts on General Gravitation and Views Thence Arising as to the State of the Universe," London, 1777. See pp. 8 f. and 13.

[15] Thomas Wright: "An Original Theory or New Hypothesis of the Universe," London, 1750.

[16] *op. cit.*, p. 57.

[17] C. A. Lubbock: "The Herschel Chronicle," Cambridge, 1933, p. 186.

DEPARTMENT OF HISTORY AND PHILOSOPHY OF SCIENCE, UNIVERSITY COLLEGE, LONDON W.C.1.

Haro's Nova in Scorpius

By WILLIAM C. BRAUN

The discovery of Dr. Haro's Nova was announced on *Harvard Announcement Card No. 1091* (August 11, 1950). It was photographed by the writer on August 13 with the 10-inch Cook Telescope, now on loan at the McDonald Observatory. The section surrounding the Nova is reproduced in Figure 1, right side. Fortunately, the writer had obtained a plate of the same region, also with the Cook Telescope, on May 23.

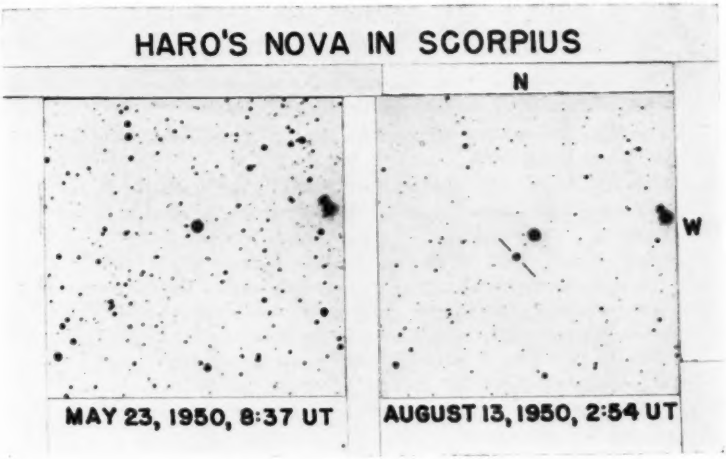

FIGURE 1

The earlier plate does not show a trace of the Nova, which places its magnitude below 16 for that date. Figure 1, left side, shows the section of the plate in question.

A plate taken on September 2, 1950, U.T., exposure time 60 minutes, places the magnitude of the Nova at 18 or fainter. The plate limit is about 18.8 magnitude but there is some slight uncertainty about the identity of the faintest images.

The bright star just northwest of the Nova is BD -35° 11992′ = HD 162287, 7.22, B9; its 1900 coordinates are $17^h\,45^m.2$, $-35^\circ\,21'$.

MCDONALD OBSERVATORY, SEPTEMBER 5, 1950.

The Planets in November, 1950

By RAYMOND H. WILSON, JR.

NOTE: The time employed is Central Standard Time unless otherwise indicated. The phenomena have been chosen and described for the North American continent, and especially for the United States. The basic data have been taken principally from the *American Ephemeris and Nautical Almanac*.

Sun. By the end of this month the sun will have retreated to nearly 22 degrees south declination, which is practically its winter extreme.

Moon. The phases of the moon will occur as follows:

Last Quarter	November 2	7 P.M.
New Moon	9	5 P.M.
First Quarter	16	9 A.M.
Full Moon	24	9 A.M.

The moon will be nearest to the earth on November 10.

Again this month there will be an occultation of the Pleiades. It will be visible from the north-central regions of the United States on November 24 at about 5 A.M.

Evening and Morning Stars. At sunset Mars may be glimpsed low in the southwest, while Jupiter will be near the meridian. Saturn will be rising after 3 A.M.

Mercury. Mercury will pass superior conjunction with the sun on November 1, and will be practically unobservable during this month.

Venus. As it passes superior conjunction on November 13, Venus will be invisible during this month.

Mars. Setting by 7 P.M., combined with faintness and extreme southern declination, will leave little chance for more than unfavorable glimpses of Mars during this month.

Jupiter. Since it will be on the meridian at about sunset, Jupiter will be most conveniently situated for early evening observation. On November 16 the moon passing only a degree south of the planet will form a notable spectacle.

Saturn. Saturn will be high enough in the east, between Regulus and Spica, for practical observation at dawn. The rings will still be very narrow, but will generally continue to widen for the next seven years.

Uranus. Uranus will be slowly retrograding west-northwestward at about 2 degrees south of ϵ Geminorum.

Neptune. Neptune will be moving southeastward at about a degree to the southeast of θ Virginis.

Department of Mathematics, Temple University, Philadelphia, Pa.
September 1, 1950.

Occultation Predictions for November, 1950

(Taken from the *American Ephemeris*)

The quantities in the columns *a* and *b* are given for the purpose of making these predictions useful for any place within 200 miles of the point indicated. The procedure is as follows: Subtract the longitude of the point given from the longitude of the place in question; multiply the result in degrees, taking the

signs into account, by the quantity under *a* for the star to be observed; similarly, with the latitude, using *b*; apply the sum of the products, with its proper sign, to the Greenwich C.T., and obtain the predicted Greenwich Civil Time for the phenomenon at the place of observation. To obtain Eastern Standard Time it is necessary to subtract five hours; Central Standard Time, six hours, etc.

Date 1950	Star	Mag.	IMMERSION Greenwich C.T.	*a*	*b*	Angle E from N	EMERSION Greenwich C.T.	*a*	*b*	Angle E from N
			h m	m	m	°	h m	m	m	°
Occultations Visible in Longitude +72° 30′, Latitude +42° 30′										
Nov. 7	*f* Virg	5.9	10 31.4	..	..	192	10 57.0	..	..	238
17	39 Aqar	6.2	2 9.4	—1.2	—0.8	80	3 10.4	—0.1	+0.6	210
20	ϵ Psc	4.4	19 47.0	+0.3	+2.3	13	20 27.5	—0.4	+1.1	287
26	354 B.Taur	6.3	4 33.6	—1.9	+1.4	73	6 3.4	—2.2	—0.1	269
28	47 Gemi	5.6	5 36.0	—2.0	—0.9	125	6 56.2	—2.2	+1.4	251
28	134 B.Gemi	6.5	9 18.4	—1.7	—1.0	96	10 36.1	—0.8	—2.3	303
Occultations Visible in Longitude +91° 0′, Latitude +40° 0′										
Nov. 4	34 Leon	6.4	12 9.5	—1.4	—1.4	138	13 30.1	—1.8	—1.1	295
15	ϕ Capr	5.4	21 46.5	—2.4	+0.3	116	22 34.9	—0.8	+2.2	189
17	39 Aqar	6.2	1 44.8	—1.3	+0.5	53	3 0.3	—1.0	+0.2	231
24	η Taur	3.0	11 24.9	+0.1	—1.7	107	12 19.7	—0.1	—0.4	240
26	354 B.Taur	6.3	4 4.4	—0.9	+2.4	56	5 22.4	—2.0	+0.6	274
26	107 B.Auri	6.5	13 17.5	+0.9	—2.7	148	13 53.3	—0.5	0.0	225
28	47 Gemi	5.6	5 4.1	—1.5	+0.1	119	6 16.1	—1.3	+2.1	245
28	134 B.Gemi	6.5	8 46.5	—2.0	—1.6	124	10 13.4	—2.2	—0.6	268
Occultations Visible in Longitude +98° 0′, Latitude +31° 0′										
Nov. 4	34 Leon	6.4	12 26.4	..	..	186	13 11.7	..	..	246
17	39 Aqar	6.2	1 27.1	—1.9	+0.8	58	2 47.9	—1.1	+1.0	221
26	354 B.Taur	6.3	3 41.1	—0.8	+1.8	69	4 59.6	—1.5	+1.3	256
28	47 Gemi	5.6	4 58.5	—2.2	—2.1	146	5 40.4	0.0	+4.4	212
28	BD+27°1337	6.4	5 39.2	—0.7	+3.1	51	6 42.6	—2.4	—1.4	311
28	134 B.Gemi	6.5	9 7.8	..	..	178	9 37.3	..	..	211
Occultations Visible in Longitude +120° 0′, Latitude +36° 0′										
Nov. 4	34 Leon	6.4	11 55.3	..	..	198	12 10.1	..	..	217
6	BD+1°2624	6.4	13 25.4	—1.4	+1.0	95	14 23.6	—0.6	—1.8	341
14	234 B.Sgtr	5.9	1 21.9	..	..	136	1 52.0	—3.2	—0.4	183
17	39 Aqar	6.2	1 7.6	—0.5	+2.8	4	2 2.9	..	..	285
17	45 Aqar	6.1	5 34.3	—1.3	—0.6	79	6 36.1	—0.1	+0.9	209
18	*h* Aqar	5.6	4 52.1	—2.3	—0.7	90	5 52.1	—0.1	+2.1	190
23	47 Arie	5.8	11 17.7	—0.4	—2.5	118	12 10.0	—0.9	+0.9	215
26	354 B.Taur	6.3	3 57.4	..	..	9	4 25.6	..	..	319
28	47 Gemi	5.6	4 41.0	0.0	+1.1	93	5 44.0	—0.4	+1.3	264
28	134 B.Gemi	6.5	7 50.0	—2.2	—1.4	137	8 56.0	—1.8	+3.0	232

METEORS AND METEORITES

Meteor Notes from the American Meteor Society

By CHARLES P. OLIVIER, President

It is well at intervals to call the attention of our members to work and publications from other countries, dealing with meteoric astronomy. The series of bulletins issued by the Institute d'Astrophysique de Paris called "Documentation des Observateurs" frequently have good résumés and discussions of import-

ant publications, many dealing with meteors. Other subjects, which serious amateur observers or students of astronomy would be interested in, are also treated. I thing that some of our members would like to subscribe. The address of the Institute is 98 bis, Boulevard Arago, Paris (14e) France. The annual subscription cost is not stated but is probably not high.

The *Astrophysical Journal* of January, 1950, has two very important articles on our subject. The first is: "A Photographic Study of the Draconid Meteor Shower of 1946" by Jacchia, Kopal and Millman; the second is a highly theoretical paper by Wyatt and Whipple entitled: "The Poynting-Robertson Effect on Meteor Orbits." In these Notes I desire to quote extensively from the first article mentioned, which is done with the permission of the *Astrophysical Journal* and for which due appreciation is hereby expressed. I shall, however, make a few preliminary remarks, dealing with the development of meteoric astronomy in America during my memory. Although outstanding early work had been done in this country, this more or less came to an end with that of H. A. Newton about 1892. Elkin at Yale indeed pioneered in photographing meteors from 1891 to 1909, though I was unable to publish his full results before 1936.* A little desultory work was done during the Leonid showers of 1897 to 1901 at Harvard and elsewhere, but, in general, professional astronomers totally ignored meteors for some decades. Hence my own work, which started when a boy in 1898 and continued as I later became a "professional," and the work of the A.M.S. which started in 1911, filled a real need. Now, however, the picture has wholly changed. Already by 1930 young persons of marked ability had become interested, and several of them have become professional astronomers who have done brilliant work in the field of meteoric astronomy. Among them P. H. Millman, one of the writers of the article to be reviewed, is responsible for the organization and direction of the fine work done in Canada since he joined the staff of the Dominion Observatory there.

Before going further, a word of encouragement must be said to our members of the A.M.S. and other amateurs. While the extensive equipment and resources at the disposal of such outstanding men as Millman permit them to secure results of the greatest value and accuracy, this does *not* destroy the value of the type of work done by amateurs. One supplements the other, and visual observations are still most necessary for the average night and for numerous meteoric problems. Photography as yet catches the brighter meteors only; it is most expensive to carry on, and the computations of the results hard and long. Only visual observers see the fainter meteors and, for instance, can derive hourly rates, one of the most important things for theory. Therefore I can assure everyone that visual observations are still desired and valuable, and are needed to help interpret some of the results obtained by radar and photography. This will also remain true for the indefinite future.

Returning now to our review, the work done by Millman and his colleagues was only possible due to the policy of our Army and Navy to support work on the upper atmosphere, knowledge of which is imperative for national defense. The authorities in Canada, our ally, have a similar attitude. Hence, when it seemed that it would be cloudy at Ottawa, the Canadian Air Force at once transported his party and equipment to where the sky was clear, the place being North Bay. Funds from the Bureau of Ordnance, U. S. Navy, permitted the computation of the results, which latter was done at Massachusetts Institute of Tech-

**Astronomical Journal*, Vol. XLVI and *Flower Observatory Reprint*, No. 38.

nology. Quoting from the abstract of the paper, the authors say: "The cosmic spread of the radiant (is) 6°2, more than half of which is probably due to observational errors. This is much less than the spread of any of the other showers investigated so far, and together with the fact that no Draconid meteors are observed except in the immediate neighborhood of the parent comet, points to a relatively early stage of disintegration of the swarm. The visual paths . . . proved to be of considerably shorter duration than those of most normal meteors and, considering their low geocentric velocity, were visible at abnormally great heights (between 90 and 98 km. on the average). The observed decelerations would point to masses which are, on an average one hundred times smaller than those of other meteors of comparable brightness and geocentric velocity. All this indicates that the Draconid meteors are probably composed of "soft" material, which is more easily vaporized. . ."

The instruments used were three cameras and two spectrographs, all mounted so one rotating shutter was in front of them. The date was 1946 October 9/10 and exposures were started about 8:25 P.M., E.S.T., and were kept up for four hours, until the shower was practically over. Altogether 206 meteors were photographed, all but two being Draconids. A visual group of 5 observers tried to plot the very bright meteors seen in the regions covered by the cameras. Of these, 27 were definitely identified as being also on the plates, thus giving a visual check on the photographic magnitudes. The visual results have not yet been published. The geocentric velocity of the meteors was calculated, from theory, as 20.433 km/sec, and when corrected for zenith attraction as 23.257 km/sec. The observed position of the true radiant at October 10.16, G.C.T., was $\alpha = 262°.07 \pm 0°.13$, $\delta = +54°.09 \pm 0°.04$, only 4°.5 from its computed position. This radiant is actually based upon 180 meteors, divided into 14 groups, each group later in time than the former. From these a daily motion of the true radiant was derived as follows: $\Delta\alpha = +2°.1 \pm 0.9$, $\Delta\delta = -0°.1 \pm 0°.4$ or a total daily motion of $1°.3 \pm 0°.6$. The table gives extensive data on all these meteors, including beginning and ending heights, magnitude, etc. The most unexpected thing was the greater heights at which they appeared and disappeared, namely 97.7 km and 89.9 km, with average deviations of 4.45 km and 5.31 km, respectively, whereas for normal meteors of geocentric velocity between 20 and 25 km/sec these figures would be about 90 km and 70 km. The brighter meteors penetrated lower, as might be expected from their greater mass. Measurements indicated that all the meteors photographed ranged between $+1^m0$ and -6^m0; 131 being, however, between 0^m0 and -2^m9, inclusive. Reducing their durations to that of a vertically incident meteor it was 0°.44, whereas on the Harvard patrol plates meteors with a geocentric velocity of 23 km/sec give 1°.25, almost three times as long. This leads to the conclusion drawn by the authors as to their composition, mentioned already.

The above brief review of this most important and successful piece of work perforce leaves out the details and the methods of reduction. To my knowledge, however, it is the best ever done on a meteor shower on a single night. We await with impatience the publication of the visual observations made by Millman's group, which supplement their photographic observations.

Our members will remember that, in Meteor Notes beginning in December, 1946, and running through 1947, we published data sent on this shower from every obtainable source. It is still my hope to deduce from these data some really authentic information upon the true density of the stream, but so far only some preliminary work has been done, due to the press of other duties. While few if any Draconids have been detected in the years between 1933 and 1946, still

meteor observers should try to work on the nights from October 8 to 10 inclusive, on the chance that a few may appear. In any case they would not be wasting their time as October is one of our best months for meteors, no matter what night one observes.

The writer is particularly anxious to secure further reports on the brilliant fireball and train seen on 1950 June 23 over the Gulf of Mexico and the Gulf States. Will any reader please supply him with data in his possession? No attempt was made this year to put out the usual publicity on the Perseids, so, to date, not very many reports have arrived. From those at hand it seems to have been of at least average intensity. Will our members make more efforts to observe the main showers in October, November, and December? And also will all be more alert in reporting fireballs seen by themselves or by others they know? Only by concerted and continuous effort can our Society attain its ends. Too many of our members seem to make no real effort to do their share.

Flower Observatory, Upper Darby, Pa., 1950 August 19.

Contributions of The Meteoritical Society

(Known Formerly as The Society for Research on Meteorites)

Edited by FREDERICK C. LEONARD

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A Preliminary Report on Indian Ruins Discovered Near the Crest of the Barringer Meteorite Crater, Arizona*

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ABSTRACT

References to the superstitious fear with which the Barringer Meteorite Crater, near Canyon Diablo, Arizona, was regarded by the native dwellers of the Southwest, and to their avoidance of the Crater site, are abundant in the literature of meteoritics. Discovery of points and other artifacts on the flanks of the Crater by the Ohio State University Meteorite Expedition of 1939 first cast doubt on the validity of legendary scare-stories concerning the Indians, and this doubt was intensified by the discovery, in 1948-49, of remarkable arrowheads and pottery-shards, well up on the rim of the Crater, by Mr. Theodore E. Johnson, the Custodian of the Crater. In an effort to settle the question of possible Indian occupancy of the rim, archeological investigations were carried on by the Institute of Meteoritics at the Crater in the summer of 1950. As a result, not only were many points and other artifacts collected, but also Indian ruins, constructed from blocks of the Coconino sandstone occurring in the Crater rim, were discovered. One of these ruins, situated only 250 feet below the crest of the Crater rim, was completely excavated by Institute personnel, and is believed to date from A.D. 1300, at the latest.

The literature of meteoritics abounds in references to the superstitious fear with which the Barringer Meteorite Crater, near Canyon Diablo, Arizona, was

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regarded by the native dwellers of the Southwest, and to their meticulous avoidance of the Crater site; *e.g.*, H. H. Nininger has described in detail, not only the circumstances of the fall of the great meteorite, but also the subsequent ceremonies at which the tribal medicine-men instituted strict tabus on everything associated with the place of fall, thereby placing the Crater perpetually "out of bounds" to the Indians.[1] Doubt was first cast on the validity of these legendary "scare-stories" concerning the Indians by the discovery of points and other artifacts on the flanks of the Crater by the Ohio State University Meteorite Expedition of 1939, and this doubt became intensified when, in 1948-49, Mr. Theodore E. Johnson, the Custodian of the Crater, discovered, well up on the rim itself, several remarkable arrowheads and pottery-shards.

In an effort to determine whether or not Indians had once dwelled on the Crater rim, Mr. Boyd Wettlaufer, of the Department of Anthropology of the University of New Mexico, who has had considerable experience in conducting archeological excavations, was placed in charge of one phase of the investigations of the Institute of Meteoritics at the Crater during the summer of 1950. Mr. Wettlaufer's activities resulted not only in the recovery of a wealth of artifacts (points, pottery-shards, manos, metates, *&c.*) but also in the discovery of several Indian ruins located high up on the Crater rim. One of these ruins was completely excavated by Institute personnel under the supervision of Mr. Wettlaufer. The purpose of the present communication is to give a brief preliminary report on the results secured from this excavation.

The ruin excavated was found to be a single-room structure with a centralized fire-pit. It contained much ash and many pottery fragments, thereby proving that it had been a dwelling. Local stone (blocks of the Coconino sandstone from the Crater rim) had been used as building material, and the masonry was very crude, only a few rocks having been purposefully shaped. Since the ventilator shaft constituted the only break in the rock walls, entry to the original dwelling was thru the roof, as is customary in dwellings of this type.[2] On the basis of the characteristics of the ruin and of the associated artifacts, it is believed that the dwelling was built prior to A.D. 1300.

The presence, within 250 feet of the crest of the Crater rim, of this and neighboring Indian dwellings, all made from stone thrown out by the meteoritic impact that formed the Crater, indicates clearly that the early Pueblo peoples had no fear of the Crater location. Indirectly, one may infer that the Barringer Meteorite Crater is of much greater antiquity than the Indian ruins, thus effectively disposing of the conjecture that the sudden and mysterious disappearance of some of the Indian tribes in Arizona, about 700 years ago, resulted from the meteoritic fall that produced the Crater.[3]

Further field and laboratory work by Institute personnel, under the supervision of Mr. Wettlaufer, is being carried on, and a complete report on the results of these investigations will be published at a later date.

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The Lost Port Orford, Oregon, Meteorite (ECN = + 1245,428:)*

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Abstract

In 1859, when Dr. John Evans, government geologist, was working in southwestern Oregon, he came upon an unusual rocky formation protruding from the ground. He reported the locality as "about 40 miles from Port Orford." Specimens analyzed in New York and Vienna were found to be pallasite. Plans were made to move the mass, estimated to weigh 10,000 kg., to the Smithsonian Institution, but, before the expedition could be organized, Dr. Evans died. No one else could be found who knew the location of the find. The Smithsonian Institution has a small specimen of the original find weighing 28 gm. The large mass has not since been located, altho search parties are frequently in the field.

In 1859, Dr. John Evans, government geologist for Washington and Oregon, was exploring the southern coastal regions of the latter state. He often sent rock specimens to eastern scientists for careful analyses. Many of these went to Dr. Charles T. Jackson of New York City. One day, as Dr. Jackson was studying a package of newly-arrived specimens, he met with a distinct surprise. One piece was not like any known terrestrial rock. It consisted of a general network of metal, in the interior of which stony material was held. Chemical analysis of the silvery-looking metal showed it to be composed principally of iron and nickel, with the latter making up about 9%. This fact at once aroused intense interest, since alloys of iron and nickel are the chief characteristics of metallic meteorites. Tests of the stony filling showed it to be principally glassy olivine crystals, another constituent of stony-iron meteorites or lithosiderites. The identification seemed complete. Dr. Jackson sent some of the sample to Vienna, Austria, for final verification. There, Haidinger fully agreed with Jackson's findings. He placed the specimen (of weight 3.53 gm.) in the Imperial Mineral Cabinet, where it remained until just before World War II. It may still be there, but we have no late news regarding it.

When Dr. Evans was informed of the meteoritic nature of his find, he became very enthusiastic and furnished from memory a description of the original mass from which the sample was taken. He said that he was greatly surprised at the appearance of the mass when he first looked at it. It was partly buried in the ground. He estimated that fully 10,000 kg. were above the surface. He wrote to Dr. Jackson that "the mass, about 3 feet of which is above the ground, is in the mountains about 40 miles from Port Orford. I hope the Society [the Boston Society of Natural History] will take speedy and proper measures to secure its deposition by the government in the Smithsonian Institution."

Individual scientists at once began to petition Congress to appropriate funds to obtain the valuable Oregon meteorite for the Washington institution. Finally, it was decided that the appeal would be more forceful if the Boston Society as a body would join in the request, and it did so. Informed of this action, Dr. Evans began to make preparations for revisiting the locality of his find. In letters to Dr. Jackson he wrote:

"There cannot be the least difficulty in my finding the meteorite. The western

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face of Bald Mountain, where it is situated, is, as the name indicates, bare of timber, a grassy slope, without projecting rocks in the immediate vicinity of the meteorite. The mountain is a prominent landmark, seen for a long distance on the ocean, as it is higher than any of the surrounding mountains. It would doubtless be best and most economical to make the preliminary visit to the locality accompanied by the two voyageurs alluded to in my last letter [two French Canadians].

"Arrangements might be made with the Indians for its purchase and the best plan selected for its removal. It would be expedient to procure men and animals in the Umpqua Valley, east of the Coast Range, as Port Orford at present is a small settlement, altho a port of entry. The meteorite might be shipped in the California steamer to San Francisco and from that port in a sailing vessel around Cape Horn to Boston.

"As to the dimensions of the meteorite, I cannot speak with certainty, as no measurements were taken at the time. But my recollection is that 4 or 5 feet projected from the surface of the mountain, that it was about the same number of feet in width, and perhaps 3 or 4 feet in thickness. It is no doubt buried deeply in the earth, as the country is very mountainous and subject to washings from rain. The mass is quite irregular in shape."

The Vienna account of the sample stated that "the fragment shows some of the fine original fusion crust, so that the mass, altho exposed, has not oxidized since its arrival on the Earth." The fact that it was still well preserved leads to the belief that it was then a fairly recent fall.

But the best laid plans of men are often thwarted. In 1860, before arrangements were completed for the intended visit to the site, Dr. Evans died in the year following his find. He left no written directions, at least none that could help others. Most of his original party were scattered, and no one knew where to find any of them. Everything came to a sudden halt. After Dr. Evans' death, Dr. Jackson published his correspondence, hoping "by the aid of the information contained in the letters to me some traveler in these regions may be able to find the very interesting meteorite."

No doubt exists in the minds of scientists that this rare object still lies in the mountainside. It may be covered now with material washed down from greater heights; it may be more exposed than it was when it was found. The surface crust is likely well rusted and deteriorated by this time. In scientific writings this valuable mass is referred to as the "lost Port Orford meteorite." The statement that the location is "about 40 miles from Port Orford" is quite indefinite. Haidinger, speaking before the Vienna Academy of Science in 1860, said:

"It lies in the Rogue River Mountains not very far from Port Orford on the Pacific, about in latitude 42° 46′ north and longitude 123° to 124° west." O. C. Farrington, in 1909, in his "Catalog of the Meteorites of North America" (*Mem. Nat. Acad. Sci.*, **13**, 1915), gave the location as "latitude 42° 46′ N., longitude 124° 28′ W." (p. 358). This is simply very nearly the location of Port Orford.

In 1932, Dr. H. H. Nininger, the well-known meteoritical authority and an Ex-President of The Meteoritical Society, made a search of the region most likely visited by Dr. Evans. He writes that "unfortunately there are three Bald Mountains in the vicinity, not one of which is any longer bald. However, I think there is no doubt that the meteorite is somewhere around there."

As far as is known, only 30 gm. of Dr. Evans' specimen are now preserved.

Aside from the 4 gm. in Vienna, the rest is in the Smithsonian Institution (United States National Museum) in Washington, D. C. Fig. 1 shows a photograph specially taken for me in 1949 at the Smithsonian Institution. I am told

LOST PORT ORFORD METEORITE
38-gram mass in the Smithsonian
Institution, Washington, D.C. Photo
by Smith. Instit. January 1949

FIG. 1

that the specimen is still in good condition. The crystals are greenish-yellow, and the fragment is a pallasite of the Krasnojarsk group (Lpa(Kra.)).

In the winter of 1937-38, I attempted, thru magazine-section articles in *The Portland Oregonian* and *The San Francisco Chronicle*, to inspire a search of the Port Orford area by non-scientific persons. Stacks of letters and boxes of samples at once began to pour in. All bare hillsides in southwestern Oregon and those that may have been bare a century ago were carefully inspected. The report got out in the summer of 1938 that in some places these "treasure hunters" were creating a distinct fire hazard in the National Forest. Most of the searchers were "on their own." Five asked me to grubstake them, offering all the way from the simple return of the grubstake to half of the "thousands" that they hoped to realize from the sale of the precious object. Cranks of various kinds asked cash advances on their statements that they had machines that would locate any sort of mineral without fail. Scores made identical requests by asking for "more information than was given in the papers," in order that they might go more easily to the correct location. All wanted to know just where to look, so as to waste no energy by searching in the wrong places. My original idea was to have the entire possible territory looked over. I do not yet have any idea as to the exact location of the "right place."

In January, 1938, a letter was sent to the Vienna Academy of Science in an attempt to gain any further available information. When Hitler took possession of Vienna early in March of that year, no reply had been received, and hopes dimmed. On March 20, however, a long, cordial letter arrived from the Secretary General of the Akademie der Wissenschaften in Wien (Vienna). He made a splendid effort to help us, but furnished no additional information.

In July, 1938, the story was widely circulated in the Pacific Coast papers—it got even into the New York magazine, *Time*—that Robert M. Harrison of Myrtle Point, Oregon, had found the long-lost meteorite and had been offered $50,000 for it by the Smithsonian Institution. Many people in that locality, interviewed by newspaper correspondents, felt sure that the story was true. It was said that, in 1900, Mr. Harrison had filed a mineral claim in a gulch thru which Poverty Creek flows, largely because of a large rock found there that seemed to be rich in nickel and extremely tough and heavy. Mr. Harrison stated that shortly after that time he sent a sample of the rock to Dr. J. F. Diller, federal geologist, and that the latter wrote Harrison that the sample was without doubt meteoritic.

When the story of July, 1938, would not down, a request for information was directed to the Smithsonian Institution. Dr. W. F. Foshag replied that they had offered nothing to Harrison, and that they were convinced that he knew nothing about the location of the lost Port Orford meteorite. It was later learned that Congress had passed an act in 1900 that gave anything of museum value in national forests to the Smithsonian Institution. The Institution later wrote me that they would not be required to pay a finder if the meteorite should be located in a government forest, "since it would already belong to us." They did say, however, that they would likely pay a reward, but did not specify the amount.

I have had some correspondence with Mr. Harrison, but have never been able to get him to send me a sample. A story in *The Portland Oregonian* of July 21, 1938, stated that "samples were recently sent for qualitative analysis to the state laboratory at Grants Pass and to Pruett at Eugene." I have not yet received my specimen. Some time after the newspaper account, I heard that the state laboratory also was still looking for its piece.

Synthetic Schreibersite*

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ABSTRACT

A simple preparation of 2 synthetic nickel-iron phosphides is described. One has the physical properties and chemical composition of schreibersite. The other is non-magnetic, is almost insoluble in acids, and has an analysis similar to 3 anomalous analyses of phosphide from the Canyon Diablo, Arizona, siderites.

It has long been recognized that schreibersite has a composition close to $(Fe, Ni, Co)_3 P$, and, in 1938, I presented evidence that most of it tends to approach the composition $Fe_3 (Ni + Co) P$.[1] Analyses showing abnormally low phosphorus contents are the result probably of inclusions of metal within the schreibersite grains.[1,2] Farrington[3] has reviewed some of the literature on the synthesis of phosphides of nickel and of iron, altho some of the compounds men-

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tioned could hardly have been schreibersite, unless they were very impure. More recent studies of the iron-phosphorus diagram, below 30% phosphorus, indicate the existence of Fe_2P and Fe_3P; and FeP and FeP_2 also have been prepared.[4] Of these, Fe_3P is tetragonal, and may be regarded as synthetic iron-schreibersite. The reference[4] does not discuss the nickel-phosphorus system, but it seems probable that a nickel-schreibersite, Ni_3P, could exist. As far as I am aware, no synthetic nickel-iron phosphides have been previously described.

Preliminary experiments showed that mixtures of powdered iron and red phosphorus unite chemically when heated in a test tube. A greenish glow spreads thruout the mass and produces a somewhat foliated black mass quite unlike schreibersite. It was thought that fusion of this product might produce the desired material; so nickel and iron powders mixed with an excess of red phosphorus were heated. When the reaction was over, the product was fused in an induction furnace in an alundum crucible until white fumes were no longer given off. The resulting button was rather porous, softer than schreibersite, and completely non-magnetic. A sample was sent to Mr. F. G. Hawley for analysis, and he reported that it was extraordinarily resistant to ordinary acids, but that the fine powder did dissolve slowly in boiling sulfuric acid containing some potassium acid sulfate. The result of his analysis is given in Table 1, in comparison with the figures calculated for Fe_2NiP_2. The agreement is sufficient to show that the material is not schreibersite; hence, its chemical resistance and lack of magnetism are not surprising. The phosphide Ni_3P_2 exists, but it is reputed to be soluble in nitric acid. It is possible that a compound similar to this does exist in meteorites.

TABLE 1

	Calc. for Fe_2NiP_2	Found	Canyon Diablo (Ogg) Schr.	Rhab.
Fe	48.0%	55.6%	72.43%	72.15%
Ni	25.3	19.8	.....	.....
P	26.7	23.1	26.46	25.95
	100.0%	98.5%	98.89%	98.10%

The table contains also an analysis of schreibersite and one of rhabdite from the Canyon Diablo, Arizona, meteorites.[5] A third analysis was similar, and a trace of nickel also was reported. If Moissan's analyses are erroneous, it is a remarkable fact that the phosphorus contents are in good agreement with that calculated for Fe_2NiP_2. All other analyses of phosphides from these siderites are normal, however, or nearly so.

A second experiment was similar, except that the metal powders and red phosphorus were mixed in approximately the proportions calculated for Fe_2NiP. This time the button, tho still somewhat porous, was materially harder, was strongly magnetic, and had the composition shown in Table 2. Two (2) analyses of typical schreibersites of similar composition from the falls of Bendegó, Bahia, Brazil (Og,a), and Coahuila, Mexico (H), also are given.

TABLE 2

	Calc. for Fe_2NiP	Found	Bendegó (Og,a)	Coahuila (H)
Fe	55.5%	53.6%	52.42%	51.60%
Ni	29.1	30.0	} 33.51	30.89
Co	....	....	}	0.70
P	15.4	14.6	15.09	14.63
Misc.	....	....	0.25	0.78
	100.0%	98.2%	101.27%	98.60%

Measurable crystals were not obtained, but a substance with the composition, color, luster, hardness, brittleness, and magnetism of schreibersite was prepared and can be regarded probably as synthetic schreibersite. Its Rockwell hardness could not be measured accurately because of the presence of bubbles, but that quantity appeared to be near 65 on the *A*-scale.

References

[1] J. D. Buddhue, *C. S. R. M.*, **2**, 40-3; *P. A.*, **46**, 282-5, 1938.
[2] S. H. Perry, "The Metallography of Meteoric Iron," *U. S. Nat. Mus. Bull. 184*, 20, 1944.
[3] O. C. Farrington, *Meteorites*, 152-3, 1915.
[4] L. Jordan, *Metals Handbook*, 394, 1939 ed.
[5] H. Moissan, *Compt. Rend.*, **139**, 773, 1904.

Daytime Meteors of August 7, 1869*

Dorrit Hoffleit
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Abstract and Introduction

Altho the discovery of daylight meteor-streams by radio techniques is still somewhat novel, it is of interest to discover in the old tomes references to daytime meteor-activity comparatively long ago. In checking records of early eclipse-photography, I came upon some indications of surprisingly high, daytime meteor-activity. Following are the relevant remarks, quoted from "Reports of Observations of the Total Eclipse of the Sun, August 7, 1869" (Appendix No. 8 to the *Report for 1869 of the U. S. Coast Survey*).

1. *Memorandum by Arthur Searle, who was stationed at Falmouth, Kentucky*, p. 19: "Mrs. Murphy saw 2 meteors during the total phase. The first was traced from a point near the meridian and not far from the zenith, toward the southeast; the course of the second was from the northwestern to the southwestern part of the sky."

The duration of the total phase at Falmouth was 45 seconds. Mercury, Venus, Regulus, Arcturus, Vega, and Saturn were visible during totality. Point of divergence of the 2 meteors, "probably in the northwest."

2. *Account by G. M. Searle, who observed at Shelbyville, Kentucky*, p. 23: "Mr. Alvan G. Clark, who observed the eclipse at Shelbyville thru the finder of the Shelbyville equatorial, states that, after the first contact, which was promptly seen by him, nothing of especial interest occurred until the Sun was about half covered. Then his attention was called, by Professor Winlock,† to small objects crossing the field of the finder, in straight lines, and supposed by both observers to be meteors. Mr. Clark himself observed about 20 of these objects. Mr. Clark was able to see thru the finder, when opened to its full capacity (1½ inches), radial lines in the largest protuberance, which was situated near the base of the Sun."

3. *Report by G. W. Dean, Assistant, U. S. Coast Survey, observing at Shelbyville*, p. 26: "About 10 minutes after the total phase, I observed a faint object pass across the Moon in a southwesterly direction; in a few moments, I saw

*Read at the 13th Meeting of the Society, Flagstaff and Barringer Meteorite Crater, Arizona, 1950 September 5-7.

†[Then Director of the Harvard Observatory and head of the Shelbyville expedition.]

another, which was soon followed by another in the same general direction. Within 15 minutes I saw 10 of these faint objects pass across the Moon. They had the appearance of being meteors, and I am inclined to believe that they were. The same phenomenon was observed by Mr. Blake and also by Mr. Alvan G. Clark. The wind at that time was very light from the southeast. As my attention was required for other services, I made no observations upon the solar spots as they reappeared."

Dean used an achromatic refractor, made at Munich and formerly used as a finder on the "great equatorial"; aperture, 3 inches, focal length, 46 inches, magnification, × 30; located 20 feet west of the Shelbyville equatorial used by Professor Winlock.

4. *Report by F. Blake, Jr., U. S. Coast Survey, Shelbyville station,* p. 30: "Soon after the reappearance of the Sun, my attention was attracted to bright points of light, which were, from time to time, passing across the field. After observing 15 or 20 of them, I concluded that they passed between the Earth and the dark body of the Moon; that they always fell in the same direction, which was from the apparent upper limb of the Moon to the horizon; that their paths were straight lines, and parallel to one other; that one seen by Mr. A. G. Clark, Jr., thru a telescope which was 7 feet south and 20 feet east of my instrument, was seen also by myself; and that they were incandescent bodies. In size they were equal to the smallest stars visible thru any telescope, about as large as a 10th- or an 11th-magnitude star appears to be in the Harvard College equatorial. As the sunlight increased, these meteors ceased to be visible. As I was not looking thru the telescope during the total phase, I am unable to say whether or not they were then visible."

Blake used the 4-inch Bowditch comet-seeker, of focal length 3 feet and power × 34.

5. *Report of C. N. Fay, observing at Springfield, Illinois,* p. 47: "I saw 1 or 2 flashes across the field before totality. As they traversed the whole field, I inferred that they were the effects of nervous fatigue."

Fay used a 2-inch refractor of 7 feet focal length.

The first 2 meteors recorded, those observed without optical aid by Mrs. Murphy, would have aroused little further curiosity, but notes 2-4, on telescopically observed meteors at a rate of possibly 1 a minute, as seen with instruments of 1½ to 4 inches' aperture and relatively small fields of view, do seem worthy of further exploration. The observed frequency seems particularly significant when one remembers that the observers were concentrating presumably on the occultations of sunspots and other pre- and post-totality phenomena. Only the last of the foregoing notes indicates any skepticism as to the cause of the observed phenomena. Professor Winlock's observations and comment on the meteoric nature of the objects observed should be reliable, but did his oral remarks stimulate the other observers to the type of enthusiasm that induces spurious observations? I think it probable that most of the "meteors" seen were real; if so, was this a brief glimpse of an unusually intense shower, or an annual occurrence not yet well observed?

Daytime radio meteor-observations in early August of 1947[1] indicated an average frequency of about 1 meteor per hour. Nighttime observations on major showers had indicated that the frequency of radio meteors was closely comparable to the frequency of simultaneously observed visual meteors. Altho the meteors observed telescopically in the course of the eclipse of August 7, 1869, were recorded as being faint, it must be noted that they were observed in the course

of the *partial* phases of the eclipse, when the sky was by no means dark. If what was observed was really a meteor shower, perhaps radio observations will again reveal it. While radio equipment is being set up for nighttime observations of the early Perseids, could not a day-shift crew be observing for a possible confirmation of this suspected shower? Unless it is an annual shower, however, years of observing may be required to find it.

REFERENCE

[1] J. A. Clegg, V. A. Hughes, & A. C. B. Lovell, "The Daylight Meteor Streams of 1947 May-August," *Mon. Not. Roy. Astron. Soc.*, **107**, 369-78, 1947.

A Proposed Curriculum in Meteoritics for College Students*

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ABSTRACT

A proposed new undergraduate curriculum or "major" in meteoritics—which would be simply a "combined major" in astronomy and mineralogy—is outlined as it would probably work out at the present time at the University of California, Los Angeles, and similar institutions.

In 1938, I published, in our CONTRIBUTIONS, a 2-page paper entitled "A Proposed Curriculum in Meteoritics for College Students,"[1] to which reference should be made in connection with the present paper. In the dozen years that have elapsed since the publication of the first paper, so many changes—mostly of detail—have occurred, that it now seems advisable to formulate a new undergraduate curriculum or "major" in meteoritics, to replace the original one.

A major in meteoritics would be simply a "combined major" in astronomy and mineralogy. It would consist of certain preparatory courses to be taken by the student in the "lower division" (*i.e.*, in the first 2 years or the "junior college") and certain courses in the major proper, to be taken in the "upper division" (*i.e.*, in the last 2 years or the "senior college"). At the University of California, Los Angeles, lower-division courses are numbered from 1 to 49, and upper-division courses from 100 to 199. In the proposed curriculum that follows, under each subject (*e.g.*, *Astronomy*) are listed the number of each included course, its "unit" value (in parentheses), and its name, according to the *General Catalog* of the U.C.L.A. for the academic year 1949-50. The "unit" value of a course indicates, in effect, the number of times the class meets each week during a "semester" (*i.e.*, an academic half-year), a total of at least 120 units in all subjects taken by the student being required for the bachelor's degree in the College of Letters and Science. Besides the preparatory courses that lead up to the major proper, a "single major" consists usually of about 24 upper-division units, and a "combined major" of from 30 to 36.

Following is the proposed new undergraduate curriculum in meteoritics—which, as has been stated, would be merely a combined major in astronomy and mineralogy—as it would probably work out at the present time at the U.C.L.A. Naturally, this curriculum could be adapted to the purpose of *any* standard, 4-year college in which the same or equivalent courses are taught.

*Read at the 13th Meeting of the Society, Flagstaff and Barringer Meteorite Crater, Arizona, 1950 September 5-7.

THE PREPARATION FOR THE MAJOR PROPER IN METEORITICS[2]

Astronomy: 2 (2), practice in observing; 4 (3), spherical astronomy; 7 (3), general astronomy. Total = (8).

Chemistry: 1A (5), 1B (5), general chemistry. Total = (10).

Mathematics: 1-3A (5), college algebra and plane analytic geometry; 3B (3), 4A (3), 4B (3), first, second, and third courses in calculus. Total = (14).

Mineralogy: 6 (4), introduction to mineralogy. Total = (4).

Physics: 2A (4), 2B (4), general physics. Total = (8).

Grand total in the preparation = (44).

THE MAJOR PROPER IN METEORITICS[2]

Astronomy: 102 (3), stellar astronomy; 115 (3), determination of orbits; 118 (3), meteoritics; 127 (3), astrophysics of the upper atmosphere; 199 (3), special studies in meteoritics. Total = (15).

Geology: 101 (3), principles of geology; 103 (4), petrology. Total = (7).

Mineralogy: 101 (2), paragenesis of minerals; 102 (3), advanced mineralogy; 109A (2), 109B (4), optical mineralogy and petrography. Total = (11).

Grand total in the major proper = (33).

COURSES RECOMMENDED BUT NOT REQUIRED[3]

Statistics: 1 (2), elementary statistics, *or, better,* 131A (3), 131 B (3), statistics. Total = (2) or (6).

Chemistry: 5A (3), 5B (3), quantitative analysis. Total = (6).

Astronomy: 117A (3), 117B (3), astrophysics. Total = (6).

Chemistry: 109A (2), 109B (2), general physical chemistry. Total = (4).

Grand total in courses recommended but not required = (18) *or* (22).

Acknowledgment is due my ex-student in meteoritics and my colleague, Mr. George J. Neuerburg, M.A., Lecturer in Geology at the U.C.L.A., for valuable suggestions concerning this curriculum.

REFERENCES AND NOTES

[1] *C. S. R. M.*, **2**, 44-5; *P. A.*, **46**, 328-30, 1938.

[2] Subjects enumerated alphabetically and courses enumerated numerically.

[3] To be taken presumably when the student is in the upper division; these courses are enumerated in the order of decreasing importance to the meteoritical major.

A Recently Discovered Possible Meteorite Crater in Quebec, Canada*

An article entitled "Discovery in the Tundra," on p. 64 of *Time* newsmagazine for August 14, 1950, contains the following account of the recent discovery of a possible immense meteorite crater in the vast and barren northwestern part of the Province of Quebec, Canada:

"The northwestern tip of Quebec, just south of Baffin Island, is flat, sodden tundra sprinkled thickly with little lakes. Most of them are irregularly shaped. But Prospector Fred W. Chubb noticed, while poring over an aerial photograph, that one lake was almost round and surrounded by a wall of rock. Chubb showed

*Read at the 13th Meeting of the Society.

the photo to Dr. V. Ben Meen, Director of Toronto's Royal Ontario Museum of Geology and Mineralogy.

"This week Dr. Meen returned from a quick air visit to the lake and reported that it was almost certainly a meteorite crater (there was no lava or other sign of volcanic activity), and the biggest yet discovered. The lake in the crater (still frozen at the end of July) is 2½ miles across, compared with Arizona's famed Meteorite Crater, which is four-fifths of a mile across. Its level is about 80 feet above that of other small lakes in the vicinity, and around it is a ring of shattered granite that rises 550 feet above the tundra. The rim is lowest on the northwest side, which suggests that the meteorite came from that direction and hit the ground obliquely.

"Dr. Meen found no meteoritic iron, only a reddish rock that might prove to be the peculiar stony material of which some meteorites are made. But there was plenty of other evidence that some enormous body had buried itself in the Earth: shattered blocks of stone from football to freight-car size, and concentric circles in the granite around the crater, like ripples stirred up by a pebble dropped into still water.

"Dr. Meen estimated that the meteorite must have fallen at least 3,000 years ago, since there are no Indian or Eskimo legends about it. He named it Chubb Crater after the sharp-eyed prospector, and promised that a 'ull-dress expedition would report on it within a year."

The article is accompanied by an aerial photograph (credited to "Hermes—*Globe and Mail*, Toronto") bearing the legend, "Meteorite Crater in Quebec." Altho the view is highly foreshortened, the crater appears to be nearly circular in outline; it is completely filled by a lake which, at the time the photograph was taken, was considerably more than half frozen over. The crater is located presumably in the Koksoak River district, between Ungava and Hudson Bays. To date, we have been unable to obtain sufficiently precise information about its position to assign even a provisional coördinate number to it.—F.C.L.

Why Study Meteorites?*

A partial answer to the oft-repeated question, "Why study meteorites?," is ably and interestingly given in an article entitled "A Meteorite Crater in Quebec Is a Link in a Chain Extending Back to the Creation," under the heading of "Science in Review," in *The New York Times* for August 13, 1950, by Dr. William L. Laurence, who writes:

"Great interest was aroused last week with the announcement of the discovery at the northernmost tip of Quebec of a round lake in a circle of rock, 2½ miles across, which had been tentatively identified as the largest known meteorite crater, gouged out of the solid granite some 3,000 to 5,000 years ago by a shooting star from outer space that must have weighed millions of tons. The famed El Diablo [Canyon Diablo] Crater, southwest of Winslow, Arizona, the largest previously known, is about three-quarters of a mile across.

"The walls of the mammoth ice-filled basin rise 550 feet above the tundra. In the uninhabited plain around the crater are concentric ripples in the granite, like those formed when a pebble is dropped into a pond. At least 10 billion tons of rock, it is estimated, were gouged out of the face of the Earth. Dr. V. Ben Meen, Director of the Royal Ontario Museum of Geology and Mineralogy, who tentatively identified the crater as having been caused by a meteorite, said that if

*Read at the 13th Meeting of the Society.

a similar body struck Manhattan Island, 'the city would be torn from the Earth and life would be eliminated within a radius of 100 miles by the shock waves; the crust of the Earth would ripple like pond water.' This would equal the blast effect of 10 hydrogen bombs, each 1,000 times the power of the wartime A-bomb.

"Lessons of Meteorites.—Meteorites are, in the true sense of the word, 'cosmic Rosetta stones' from outer space. Studies of their chemical composition have given us the most tangible key to the composition of the Earth, down to its very core; to the relative distribution of the elements on the Earth and in the Solar System as a whole. This knowledge, which fits in with information obtained by less tangible methods, has led to important clues on the composition of the Universe and the relative proportions of the elements in the stars and galaxies and in the dust of interstellar space, and these, in turn, are furnishing backward glimpses into space and time on the manner in which the Universe evolved. Out of all this is slowly emerging a physicist's version of Genesis.

"Investigations during the past 50 years, climaxed by studies of Dr. Harrison Brown of the Institute for Nuclear Studies, University of Chicago, have led to the conclusion that all the meteorites that have ever struck the Earth, and still keep coming (ranging in size from a few milligrams to possibly millions of tons), are the result of a single cosmic catastrophe millions of years ago, in which a planet roughly the size of Mars, which probably occupied an orbit in the gap between Mars and Jupiter, blew up one day, no one knows why. The meteorites, it appears, are the fission fragments of a cosmic atom-bomb, the debris of a planet with a close family relationship to the Earth.

"Tangible Data.—Since some of these meteorites, those that consist primarily of an alloy of iron and nickel, are believed to come from the core of the exploded planet, a study of their composition by modern chemical methods, including the use of radioactive isotopes to detect the presence of minute amounts of metals not otherwise detectable, has provided tangible data about the composition of the Earth's interior. It turns out that there is enough gold in the Earth's core to cover its entire surface with a layer of more than 3 feet, while the quantity of platinum in the core is great enough to cover the entire Earth with a layer of 6 feet!

"These studies by Dr. Brown, bolstered by astronomical and other investigations, provide evidence which, in the words of Professor George Gamow, noted theoretical physicist, 'suggest strongly that our Cosmos is remarkably uniform in its chemical composition.' 'In fact,' Professor Gamow states, in the current issue of *Physics Today*, 'apart from a few notable exceptions, which can be easily accounted for by local conditions, the relative abundance of various chemical elements is nearly the same on the Earth, on the planets, on the Sun, and on other stars of the Milky Way system, in the diffuse interstellar material, and in the distant spiral galaxies, which represent independent stellar systems of their own.' . . ."—F.C.L.

The Council of the Society for the 1950-54 Term

At the 13th Meeting of the Society, held at Flagstaff and at Barringer Meteorite Crater, Arizona, on 1950 September 5-7, the following members of the Council (Officers and Councilors) were elected for the 1950-54 term, which commenced at the adjournment of the meeting on September 7:

President: Mr. L. F. Brady, Museum of Northern Arizona, Flagstaff, Arizona
Vice-Presidents: Dr. Lincoln LaPaz, University of New Mexico, Albuquerque
Dr. Stuart H. Perry, Adrian, Michigan
Dr. Fred L. Whipple, Harvard College Observatory, Cambridge, Massachusetts
Secretary: Dr. John A. Russell, University of Southern California, Los Angeles, California
Treasurer: Mr. John Davis Buddhue, 99 S. Raymond Ave., Pasadena 1, California
Editor: Dr. Frederick C. Leonard, University of California, Los Angeles
Director of the Meteor Section: Dr. C. C. Wylie, State University of Iowa, Iowa City

Councilors:
Dr. Carl A. Bauer, University of Michigan, Ann Arbor
Dr. Carl W. Beck, University of New Mexico, Albuquerque
Dr. Harrison Brown, University of Chicago, Chicago, Illinois
Dr. Curvin H. Gingrich, Carleton College, Northfield, Minnesota
Mr. Edward P. Henderson, United States National Museum, Washington, D. C.
Dr. Dorrit Hoffleit, Harvard College Observatory, Cambridge, Massachusetts
Dr. Joseph Kaplan, University of California, Los Angeles
Dr. Arthur S. King, Mount Wilson Observatory, Pasadena, California [*ex officio*, as President during the 1946-50 term]
Mr. Clyde W. Tombaugh, 636 S. Alameda Blvd., Las Cruces, New Mexico

Meteoritic Dust.—*University of New Mexico Publications in Meteoritics*, No. 2, "Meteoritic Dust," by John Davis Buddhue, Fellow, Meteoritical Society; Research Associate, Institute of Meteoritics; formerly with the Jet Propulsion Laboratory, California Institute of Technology, Pasadena, has just issued from the University of New Mexico Press. This monograph of the Institute of Meteoritics of the forenamed university consists of 102 pp., 4 text figs., 8 full-page plates, and 17 tables, and sells for $1.50 per copy. It may be ordered from the Editor of Publications, University of New Mexico, Albuquerque.

President of the Society: L. F. Brady, Museum of Northern Arizona, Flagstaff, Arizona
Secretary of the Society: John A. Russell, Department of Astronomy, University of Southern California, Los Angeles 7, California

VARIABLE STARS

Variable Star Notes from the American Association of Variable Star Observers

By MARGARET W. MAYALL, Recorder

1950 Annual Meeting of the A.A.V.S.O. The annual meeting of the Association will be held on Friday and Saturday, October 13 and 14, at the Harvard College Observatory. The Friday evening lecturer will be Dr. Carl W. Gartlein, of Cornell, who will tell of some of his research on aurorae.

The annual business meeting will be held Saturday morning, and the rest of

the day will be devoted to papers and discussions on variable star subjects. Dr. Shapley will give his Highlights in Astronomy for 1950 after the Annual Dinner at the Hotel Continental.

Nova in Scorpius. Three novae have been announced in the constellation Scorpius during the summer of 1950, all of them either too faint or fading too rapidly to be put on the AAVSO observing list.

The first was discovered by Dr. Zwicky of the Mount Wilson and Palomar Observatories. It was announced as of magnitude 7.5 on July 20, 1900, in position $17^h\ 38^m7$, —33° 58′. The nova faded rapidly, so that on August 9 Dr. Zwicky wrote that the only thing visible on a spectrum plate taken with the 18-inch Schmidt, was one fat H-alpha line.

Harvard Announcement Card 1091 told of a nova discovered by Sr. Haro of Tonanzintla, Mexico. The nova was magnitude 7.5 on August 7, approximate 1900 position $17^h\ 45^m$, —35° 28′. The nova faded so rapidly there was no time to produce AAVSO charts, but Sr. Haro communicated with one of our Mexican members, Sr. Taboada, and asked him to make visual observations. As a result, Sr. Taboada has sent in a fine run of 18 observations. He found it of magnitude 8.3 on August 9, 9.0 on August 15, 10.5 on August 20, and by August 26 it had faded to fainter than 12.1.

The third nova was discovered by Sr. Haro, on a spectrum plate taken on September 3, of 9.5 magnitude, 1900 position, $17^h\ 36^m$, —34° 38′. Nothing more is known about it at the present time.

Nova Lacertae 1950, 224552. Nova Lacertae has become more active again. It had a sharp maximum, somewhat brighter than 9th magnitude about July 20, and another about August 16. It should be watched very carefully for any future activity.

Société d'Astronomie d'Anvers. A few members of the Société d'Astronomie d'Anvers, of Antwerp, Belgium, have recently revived their variable star section. M. Michiels, the Secretary, has sent in their first report to the AAVSO, over 200 observations made by seven of their members from January to April of this year. Congratulations and thanks to our Belgian friends!

New Cluster-Type Variable. A. D. Code of the Leander McCormick Observatory reports in the August *P.A.S.P.* on a variable of very short period discovered by Dr. Vyssotsky. It was discovered on an objective prism plate because of its variable density across the width of the spectrum. The variable has a period of about 127 minutes, and a photographic range of from 9.5 to 10.1 magnitude; it is B.D. —0°2911, 1900 position $14^h\ 53^m8$, —0° 40′, in the constellation Libra. The cluster-type variable with the shortest known period is CY Aquarii, 223201, about 88 minutes, photographic magnitude 10.5 to 11.4.

SS Cygni, 213843. A maximum of SS Cygni was observed during the latter part of August. This is maximum number 379, and the fourth to occur during 1950. It was well observed by many members.

Suspected variables. Three more stars have been reported by AAVSO observers as possible new variables. Robert Costello estimated the faint star 2′ north of the comparison star 9.1 on the "d" chart of RS Herculis, to be of magnitude 10.8 on August 10. Robert Greenley and Costello have continued to watch the star, and Greenley estimated it to be fainter than 11.6 on August 30.

E. C. Melville observed the comparison star 12.7 on the "d" chart of X Scorpii to be of magnitude 11.9 on July 2 and 3, and of 11.6 on July 10. On July 16 and 17 it was again faint, and he estimated it as 12.8 magnitude.

On January 4, 1950, Harold Webb noticed that the 11.0 magnitude comparison star on the "e" chart of Chi Cygni was as bright as the bright star 2′ south. In the middle of August it had decreased and he estimated it as of 10.6 magnitude.

These stars should be watched, and great care should be taken if they are used as comparison stars for the known variables.

Observations received during July and August, 1950: Eighty-eight observers contributed 10,917 observations during these two months—5,904 in July and 5,013 in August.

	July—1950—August			
Observer	No. Var.	No. Ests.	No. Var.	No. Ests.
Adams	33	84	17	34
Ahnert	34	243	34	290
Albrecht	5	5	..	..
Ancarani	22	49	25	51
Ball	8	8	13	13
Bicknell	16	220	..	..
Blunck	2	4	3	12
Bogard	67	112	50	53
Boone	7	7	6	6
Buckstaff	..	..	14	47
Cain	19	24	4	6
Chandra	65	84	..	..
Charles	15	16	25	33
Chassapis	..	..	39	63
Cooke	45	127	..	..
Costello	7	9	6	7
Cragg	52	56	10	10
Dafter	..	..	8	16
De Bievre	..	..	1	1
De Kort	..	..	12	134
Diedrich, DeL.	..	..	2	4
Diedrich, G.	2	4	2	5
Dolne	..	..	7	17
Drakakis	27	103	27	95
Elias	42	456	..	..
Estremadoyro, G. A.	4	7	7	7
Fernald	265	539	263	760
Ford	45	54	47	49
Friton	..	..	2	6
Galbraith	23	104	31	137
Greenley	68	179	67	109
Halbach	37	58	2	2
Hamilton	..	..	2	2
Hartmann	78	79	84	91
Herring	31	56	30	34
Hiett	..	..	22	47
Holloway	..	..	15	24
Jerabek	2	17	14	32
Kato	34	60	..	..
Kelly	12	12	12	14
Kent	..	..	3	3
Knowles	9	41	8	24
de Kock	120	1034	115	442
Lacchini	71	200	75	184
Lankford	19	32	4	4
Lee	31	60	16	21
Leutenegger	16	44	39	157
LeVaux	58	63	61	74
Lowder	5	5	21	21
Luft	6	12	6	11
Meek	28	148	..	..
Melville	6	20	11	54
Meyer	..	..	2	2
Michiels, E.	..	..	4	29
Michiels, L.	..	..	4	20
Miller	52	78	59	109
Milone	..	..	21	33
Morrisby	9	65	7	22
Motley	6	9	13	23
Oravec	55	163	47	189
Parker	41	41	22	22
Parks	..	..	17	17
Pearcy	106	112	86	91
Peltier	48	204	52	276
Penhallow	41	74	85	189
Peter	11	187	21	210
Pierson	60	64	..	..
Reeves	..	..	1	2
Renner	175	175	204	213
Rick	1	1	..	..
Rosebrugh	16	84	11	59
Schoenke	..	..	2	2
Schulte	11	19	5	5
Sill	..	..	24	24
Snow	1	1	6	10
Stevens	..	..	20	24
Storms	..	..	8	24
Sullivan	..	..	1	1
Taboado	45	45	16	16
de Terwangne	..	..	1	1
Tifft	4	4	40	51
Toche	8	20	1	1
Upjohn	39	39	44	45
Venter	13	19	14	26
Webb	6	7	22	22
Welker	36	56	20	26
Wells	3	3	..	..
Yamada	..	..	14	23
88 Totals		5,904		5,013

Nova Search: Reports on the Nova Search Program were received during July and August from 11 observers, as follows:

	JULY		AUGUST		
Observer and Area	No. Nights	Mag.	Area	No. Nights	Mag.
Adams, 39, 40, 57, 58	9	8	39, 40, 57, 58	9	8
Blunck, 8, 9, 10	1	6	8, 9, 10	5	6
Diedrich, DeL., 40	4	4	Dome	1	1
			40	2	4
			40	1	5
			40	2	6
Diedrich, G., Dome	2	1	Dome	3	1
78	3	4	78	6	4
			78	2	6
Luft, 25, 26, 27	2	5	25, 26, 27	1	5
Rick, 18, 63	1	3	Dome	10	1
18	1	4	18	4	3
63	10	4	18	7	4
			63	3	3
			63	12	4
Rosebrugh, Dome	5	3	Dome	2	3
1	2	4	1	3	4
Smith, 3, 4	3	6	3, 4	5	6
Venter, 116, 117, 118, 131, 132, 133	1	5	..	..	..
Wells, 1-22, 57-60, 73-76, 85-87, 104-107, 113-118	3	4			
23-27, 39-45, 60-69, 75-79, 88-90, 107-109	1	4	..	..	..
Yamada, 57	2	6	19	2	6
57	1	6.5	57	10	6

September 15, 1950.

Comet Notes

By G. VAN BIESBROECK

No new comets have been announced since last July but no less than three expected periodic comets have been recovered in rapid succession during that time. This is the result of the fortunate circumstance that the powerful equipment of the Mount Wilson Observatory was made available for the purpose in the hands of L. E. Cunningham of the Berkeley Astronomical Department.

Periodic Comet 1950 *c* (Wolf No. 1). This object was located on plates taken from July 20 to 24 by Cunningham with the 60-inch reflector. It appeared as a nearly stellar image of magnitude 18.8 and subsequently was found on four plates taken in June. The comparison with Kamienski's predicted position showed that perihelion time will occur only 2½ hours earlier than was foreseen by the Polish computer and 2¼ hours earlier than the figure obtained independently by Dinwoodie (1950 *Handbook B.A.A.*). Maximum brightness is expected near the time of perihelion on October 23 but it will not exceed that of an 18th magnitude star. It is favorably located in the middle of the night.

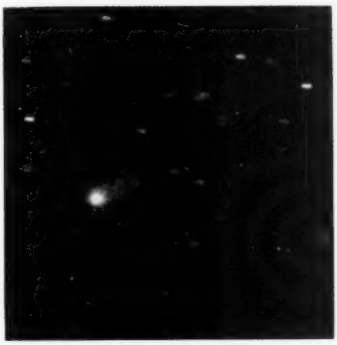
Periodic Comet 1950 *d* (Daniel). This comet was first recorded by Cunningham with the 60-inch reflector on August 16, when it began to emerge in the morning sky. Independently it was found by the writer on August 23 on plates taken with the 24-inch reflector of the Yerkes Observatory and on August 24 by Mrkos at the Skalnate Pleso Observatory. The comet showed up as a diffuse round coma some 25-inches in diameter of magnitude 17½. A change of only —0.46 days in the time of perihelion, August 23, brings the prediction by F. R. Cripps (1950

Handbook B.A.A.) in agreement with the observations. The object is not expected to get any brighter but as it rises earlier in the night the conditions of visibility will improve this fall.

The SHORT-PERIOD COMET 1950 *e* (ENCKE) which is due to reach minimum distance from the sun next March was also recovered on August 16-17 by Cunningham on plates taken with the 60-inch reflector. Having determined the precise location he found that the comet showed already on plates taken on July 21 as nearly stellar images of magnitude 21! This is by far the earliest date before perihelion that Encke's comet has ever been recorded. The prediction by R. Luss (1950 *Handbook B.A.A.*) required a change of only +0.37 day in the date of perihelion to come in agreement with the observations. Already in August the comet had brightened up by one magnitude. At present it is well located in the middle of the night. It will slowly increase in brightness until next March when it may reach naked-eye visibility before disappearing in the evening twilight.

The two comets found earlier in the year are still under observation. PERIODIC COMET D'ARREST, when last recorded here on September 7, appeared as a fairly large diffuse nebula of magnitude 12½. It slowly loses in brightness while coming nearer to opposition in November. It was mistaken for a new comet by the Rev. W. J. Miller at the Vatican Observatory on August 25.

As foreseen COMET 1950 *b* (MINKOWSKI) remains unchanged in brightness. The figure shows its appearance as photographed here on August 6. The little tail



COMET 1950 *b* (Minkowski) on August 6, 1950, 16 minute exposure with Yerkes 24-inch reflector.

about 3′ long points away from the direction of the sun. It is rapidly moving into the evening sky and will be lost in the twilight by the end of September. It will reappear as a morning object before the end of the year and still gain in brightness after that.

Williams Bay, Wisconsin, 1950 September 11.

General Notes

Dr. L. J. Comrie, well known for his valuable contributions to the science of computing, has recently been elected a Fellow of the Royal Society, London, England.

Mr. T. V. Frazier, A.B., '43 and A.M., '49, University of California, Los Angeles, has been appointed Instructor in Physics and Astronomy in the University of Nevada, Reno, beginning September 1, 1950.

Provisional Sunspot Numbers for July, 1950*

1	70	11	78	21	108
2	58	12	68	22	125
3	58	13	67	23	115
4	66	14	98	24	108
5	75	15	75	25	96
6	88	16	89	26	118
7	98	17	96	27	112
8	77	18	83	28	110
9	67	19	102	29	112
10	68	20	130	30	106
				31	100

Mean 91.0

Provisional Sunspot Numbers for August, 1950*

1	94	11	70	21	103
2	110	12	74	22	95
3	106	13	84	23	115
4	84	14	68	24	103
5	90	15	80	25	92
6	83	16	93	26	77
7	76	17	106	27	76
8	72	18	93	28	55
9	70	19	114	29	58
10	75	20	113	30	58
				31	54

Mean 85.2

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*From the Zürich Observatory, furnished by Mr. Neal J. Heines.

Hereditary Astronomers

Some famous families have each contributed through several generations to the progress of astronomy in a particularly outstanding degree. Of these, three may be specially noted. First in time, the Cassinis: J.D. (1625-1712), Jacques (1677-1756), C. F., known as Cassini de Thury (1714-1784), J. D. the second (1748-1845), all connected with the Paris Observatory during the period 1668 to 1794; next, the Herschels: F. W. (1738-1822), Caroline (1750-1848), J. F. W. (1792-1871), A. S. (1836-1907). And coming to a more recent case of astronomical heredity we have the Struves: F. G. W. (1793-1861), Otto W. (1819-1905), K. H. (1854-1920), G. W. L. (1858-1920), and Otto, the second (b. 1897). None of the Herschels was as an astronomer connected with any institutional astronomical establishment. The first two of the Struves were chiefly noted as directors of Pulkowa, the third as director of Berlin-Babelsberg, the fourth at Charkov, while Otto Struve the second is now the director of the

Yerkes, Chicago, and MacDonald, Texas, Observatories in the States, and after July 1 will be Chairman of the department of Astronomy and Professor of Astrophysics at the University of California. The work of these three families covers practically all branches of the science and an adequate account of their discoveries and activities would fill a large volume which would comprise a considerable part of the astronomical history of three centuries.

(From *The Journal of the British Astronomical Association*, **60**, 5, 148, 1950.)

The Green Ray

The Green Ray, sometimes called the Green Flash, has been explained in various ways. The following, interesting explanation, taken from the *Bulletin Mensuel de la Société d'Astronomie Populaire de Toulouse*, for June, 1949, was translated by Dr. Hyme Loss and is printed here for the benefit of our readers who may not be sufficiently conversant with the French language to understand it in the original presentation. EDITOR.

We announced in an earlier Bulletin that we would give the explanation of the fairly unusual phenomenon known under the name of Green Ray.

We were not satisfied with the explanations set forth by certain works, trustworthy though they were in other respects. It was our fortune to encounter in one of our most distinguished members one, who was at once an observer of the Green Ray (while on a cruise in the Orient) and a scholar, who has been kind enough to offer us an explanation of this phenomenon.

When in a very clear sky one observes the sunset on a sharply defined line of the horizon (sea or distant mountain ridge) the last pencil of light to reach the observer emanates from the upper rim of the sun. If circumstances are favorable the coloring thus perceived passes rapidly from red to emerald green, after which the sun is down. That is the Green Ray phenomenon, the simplest explanation of which seems to us to be the following.

As a consequence of the sun's remoteness, the pencil before penetrating atmosphere is made up of parallel rays. Penetrating the atmosphere very obliquely, the pencil is refracted at the same time as its light, originally white, is decomposed so that it progressively spreads out vertically. The index of refraction of the air progressing from red to violet and in proportion as one draws nearer to the sun, the section of this pencil passing through its axis is thus limited by two rays, at first rectilinear and parallel outside the atmosphere and which, as they pass through it, are bent gradually and unequally downward, the upper ray being red and presenting a slighter curve than the lower one which is violet and more refracted. To put it in others terms, this section is in the shape of a fan with edges unevenly bent back in the same direction, whose rectilinear handle would correspond to the portion of the pencil external to the atmosphere. On the other hand, the upright section of the pencil in the sun's neighborhood constitutes a spectrum with the red above and the violet below. Granting this, and the sun being sufficiently near its setting so that the observer, looking steadily at its upper rim, can endure its brilliance, the rectilinear portion of the pencil gradually tips under the horizon while its fanlike portion rises above the ground. The eyes of the observer thus come to be swept from the bottom upwards by the spectrum mentioned above, beginning with the red. But the last radiation perceived is the green, the remaining radiations (blue, indigo, violet) being absorbed by water vapor.

This explanation of the green ray is capable of taking the following modified

form. Let us consider at first the pencil of light emanating from a white star and penetrating the observer's eye. If the star is in the zenith the pencil reaches the eye unrefracted and undispersed and accordingly remains cylindrical. In the contrary case there is refraction and dispersion so that the pencil traversing the atmosphere spreads out vertically fan-wise, as has been said, the opening of the fan being the more pronounced the great the star's zenithal distance. *i.e.*, the nearer the star is to the horizon.

On the other hand, the tangent to the red ray, at ground level, being less elevated on the horizon than the tangent to the violet ray, the star would appear to an observer gifted with sufficient keenness of sight not as a point but as a small vertical spectrum, violet *above* and red *below*. This is verified, insofar as atmospheric disturbance permits, if a powerful magnifying glass makes up for insufficient keenness of sight: the central spot is all the more lengthened out vertically as the star is lower on the horizon, with the violet *below* and the red *above* as a consequence of the reversal of the image.

Let us now observe a sunset in the conditions described above. A few seconds before its disappearance it is reduced practically to a luminous point, and the spectrum it produces on the retina will fade away gradually starting with the red, the blue part of the spectrum being absorbed by water vapor, the last radiation perceived by the observer will then be the green. L.R.

Book Reviews

Berliner Astronomisches Jahrbuch, for 1951. (Issued by Astronomical Computing Institute and the German Academy of Sciences, Berlin. Printed by Akademie-Verlag, Berlin.)

This classic volume, the one hundred seventy-sixth in the series, needs no description for those persons who are familiar with astronomical literature. For others we may merely say that it has as its counterpart in this country *The American Ephemeris and Nautical Almanac*, and in many other countries similar year books which include at least part of the same material. Probably no other year book has such a long series, *The American Ephemeris and Nautical Almanac*, for instance, not yet having quite reached the one hundredth volume. The one before us then is to be considered the pioneer in this field. Its size and completeness indicate that it has not lost its leadership. It contains practically all of the standardized results in astronomy which remain unchanged through the years, and it contains also the current data which pertain specifically to the year 1951.

It, or a similar year book, is an indispensable part of all observatories and institutions which are even only remotely connected with astronomical matters.

The Foundations of Arithmetic, by Gottlob Frege. Translated by J. L. Austin, Fellow of Magdalen College, Oxford. (The Philosophical Library, Inc., 15 E. 40th St., New York 16, N. Y. 238 pp. $4.75.)

About twenty years ago I heard the late E. E. Slosson say that, in his best guess, science was getting ready for another bout with metaphysics. As is now clear, this was a very shrewd remark. No better testimony of its shrewdness could be asked than the publication, by a non-subsidized press, of such a book as this translation of Frege's "Die Grundlagen der Arithmetik," published originally in Breslau in 1884.

In this volume the original German text is printed on the left-hand pages and the translation on the right-hand pages. The pagination of the German text is, we read, the same as in the original German edition. The translation is by J. L. Austin of Magdalen College, Oxford, and is excellent. (There is at least one of those slips it seems impossible to avoid entirely. In the last line of page 107e, "But that will do" should certainly be "But that will not do.")

Today, almost seventy years later and with the help notably of the late G. H. Hardy and the late Morris Cohen, another Frege would perhaps improve a little, here and there, on Frege's main exposition. After the attack on Cantor by Winthrop Parkhurst and W. J. Kingsland, Jr., one can only wonder if, had he seen it, Frege would have agreed so uncritically with Cantor's doctrines of infinite numbers. And it would certainly be well to bring out, if not more clearly then more emphatically, the fact that if the excluded middle is not logically prior and self-evident and absolute, then any number of contradictions are no cause for worry.

But in general Frege would certainly be pleased by the respect now accorded his position. Except for occasional belated subjectivists like C. I. Lewis, we now seem agreed that $2+2=4$. J. S. Mill's assertion that sometimes possibly perhaps $2+2=5$ is clearly just another example of how good men can swindle themselves.

I cannot refrain from this final comment. Whatever the intelligentsia of Frege's own day might or might not have thought of such an essay as this, our contemporary intelligentsia have not the slightest excuse for being unaware of the transcendent daily practical importance of such an essay. In the recent best-selling novel by George Orwell, "Nineteen Eighty Four," they can find a sentence like this: "Liberty is the liberty to say that two and two are four."

SIDNEY RUSSELL GAIR.

Glencoe, Illinois.

Astronomy, A Textbook for University and College Students (Fifth Edition), by Robrt H. Baker. (D. van Nostrand Company, Inc., New York.)

Now for the fifth time Professor Baker presents an up-to-date text-book "for introductory courses in astronomy requiring no unusual preparation in mathematics and physics." To teachers, students, and general readers the frequent revision of this book which first appeared in 1930 has been a genuine service.

In the thoroughly revised new volume 60 pages of material have been added, divided about equally between the 10-chapter portion dealing with the celestial sphere, fundamental problems, and the solar system and the 8-chapter portion about stars, intersellar matter, and galaxies. The general arrangement of the book is changed only slightly; one notes that the planetary nebulae, formerly adjacent to the novae, have come to rest within a newly-constituted section entitled "Stellar Envelopes."

Developments in astronomy in the quadrennium 1946-49 are covered in the nearly 50 topics listed by the reviewer as new material, in the 40 sections appreciably modified or augmented, and in some 20 refinements in numerical values. In the words of the author,

"The accounts of recent progress include results obtained with the lead sulfide cell in studies of planets, satellites, and the solar spectrum, the use of new techniques in observations of meteors, the reception of microwave radiations from the sun and the Milky Way, and the investigations promoted by the increased

sensitiveness of the photoelectric cell. The accounts mention the improved understanding of circumstellar envelopes and gas streams, the detection of variable magnetic fields in the sun and stars, and the additional information about the two types of stellar population. They note the firmer opinion that the galactic system is a spiral and refer to the infrared explorations of the galactic nucleus.

"More attention than before is given to certain problems in which there is renewed interest owing to the completion of the 200-inch telescope. Among these are problems of the canals of Mars and of the red shifts in the spectra of extra-galactic systems. The somewhat more extended references to problems of cosmic development reflect the current revival of interest in these matters."

As new may be cited also material omitted in the previous edition, *e.g.*, the discussion of Zeta Aurigae, and fundamental material re-worked, such as that recognition of penumbral eclipses of the moon needed to restore symmetry to the presentation of eclipse geometry.

Nearly 60 new illustrations, largely photographs, are to be found, many being replacements. Notable are photographs of the moon and planets from Lick and McDonald; the Draconid meteors, 1946; Zeta Aurigae in and out of eclipse, direct and spectrographic; and elliptical galaxies near (the Scl object) and far (NGC 185 resolved by Baade). In the much-lengthened section on Mars additional illustrations from Barnard, Pettit, and Lyot are used. Developments made possible by the lead-sulfide conductive cell receive emphasis by inclusion of a tracing of the sun's spectrum near 16650A. Light curves of δ Cephei in three colors, the spectrum-luminosity diagrams as furnished by two types of stellar population, and diagrams of Laplace's nebular rings with Whipple's turbulent dust-cloud represent important developments in observation and theory. Pairs of spectra of super-giant and main-sequence stars as prepared and explained by Morgan provide the most concrete exhibit of luminosity effects in stars of the same spectral class which the reviewer has yet noted in an introductory text.

Several technical, possibly minor, matters were noted with interest. At several points in the text definite reference is made to a helpful published article, a very useful practise for subjects where the text-book may sacrifice much to brevity. In numerous instances attribution of recent or current researches to particular persons, who are briefly introduced, not only serves to humanize the text but aids supplementary investigation. Improvements in form and expression, attractive to the editorial eye, include economy of wording giving in many cases greater crispness and clarity, the elimination of "whose" and "while" and that irritating expression "it is easy to show" . . ., the general substitution of numerals for words (*2* for two, etc.), the addition of several definitions, and cross-referencing more adequate than previously.

Tables for aspects of the bright planets and the occurrence of eclipses (umbral lunar and total solar) have their coverage extended in general through the present decade. Review questions and problems at the ends of chapters are revised and retained.

Changes in nomenclature include the use of galactic (replacing "open") cluster, galactic cepheid (preferred to "typical Cepheid"), the Hyades (rather than "Taurus") cluster. Necessitated by the trend of events are changes in tense and wording, for Halley's Comet *has rounded* aphelion, the Hale telescope is a *fait accompli*, the Greenwich meridian goes through the *original* site of the Royal Observatory, and Schwassmann-Wachmann 1925 II is still unusual but no longer *unique!*

A few adverse comments based partly on personal preference may be offered.

The definition of *azimuth* needs a clear statement of both varieties. There are 23 lunar seas; the "14" might be mentioned as "principal" seas. Neither A stars nor early F's are blue. Radio waves are *reflected* by ionized layers in the atmosphere. Atomic *number,* not *weight,* forms the subscript of the atomic symbol. It would seem that ellipsoidal components of a binary system seen endwise (in conjunction) would appear circular in section. This reader's ideal, never remotely approached, involves labeling one or preferably two wave lengths on each spectrum photograph, and indicating orientation of all direct photographs of the sky. (In the latter case, a statement of policy and labeling of exceptions would suffice.)

In the first three editions of "Astronomy" were found such useful luxuries as lists of tables and illustrations, in the front, and in the rear an index of names with dates and brief identification. In the two later books a representative list of reference books is appended, grouped by chapter. In this 1950 volume, the list includes the first issue of the post-war "General Catalogue of Variable Stars" prepared by Kukarkin and Parenago and published by the Academy of Sciences, U.S.S.R., 1948, with information on 10,912 named variable stars.

ALICE H. FARNSWORTH.
John Payson Williston Observatory, South Hadley, Mass.

Peace

Listen to the heartbeat,
The heartbeat of the universe.
There is harmony in the universe;
All discord is on the earth.

Listen to the heartbeat,
The heartbeat of the universe.
God is in reality
A universal personality.

—ANDREW HIMANKA

In Infinity

Stars high in heaven,
Cheerful travelers of the night,
Many you have inspired
To attempt to create a pattern of you
In perpetual motion.
Your gentle laughter
At their vain attempts cannot be heard;
Until the realization of eternity dawns.

—ANDREW HIMANKA

POPULAR ASTRONOMY

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